INSTRUCTION AND MAINTENANCE
MANUAL for
PUSHBUTTON OSCILLATOR
KS-19260 L1

July 1971

Bowmar

Communications Test Equipment

Bowmar Instrument Division
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Acton, Mass. 01720
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INSTRUCTION AND MAINTENANCE MANUAL for PUSHBUTTON OSCILLATOR KS-19260 L1

July 1971

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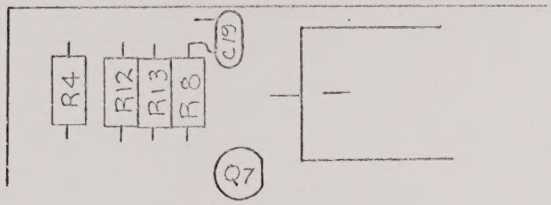
ADDENDA AND ERRATA

Dwg. No. 6. 2. 1

Add Capacitor C19 as shown below.

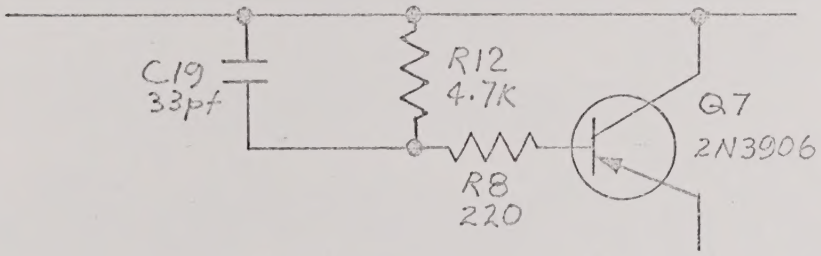


Dwg. No 6. 2. 2

Change: R35 and R36 from 825Ω, 1/8 W, 1%
to 909Ω, 1/8 W, 1%

Change: R27 and R28 from 10Ω, 1/2 W, 5%
to 47Ω, 1/2 W, 5%

Add: Capacitor C19 as shown below.



Page 7-3

Add: Capacitor, 33pF, 500V CDE CD15ED330J03

NOTE: Diodes CR6, 7, 8, 9, 10, 11 1N914 should be ITT only.

Change: from R10 Resistor, 1K, 1/4 W, 5%
to R10 Resistor, 1.02K, 1/8 W, 1% RN65C1021F

Page 7-4

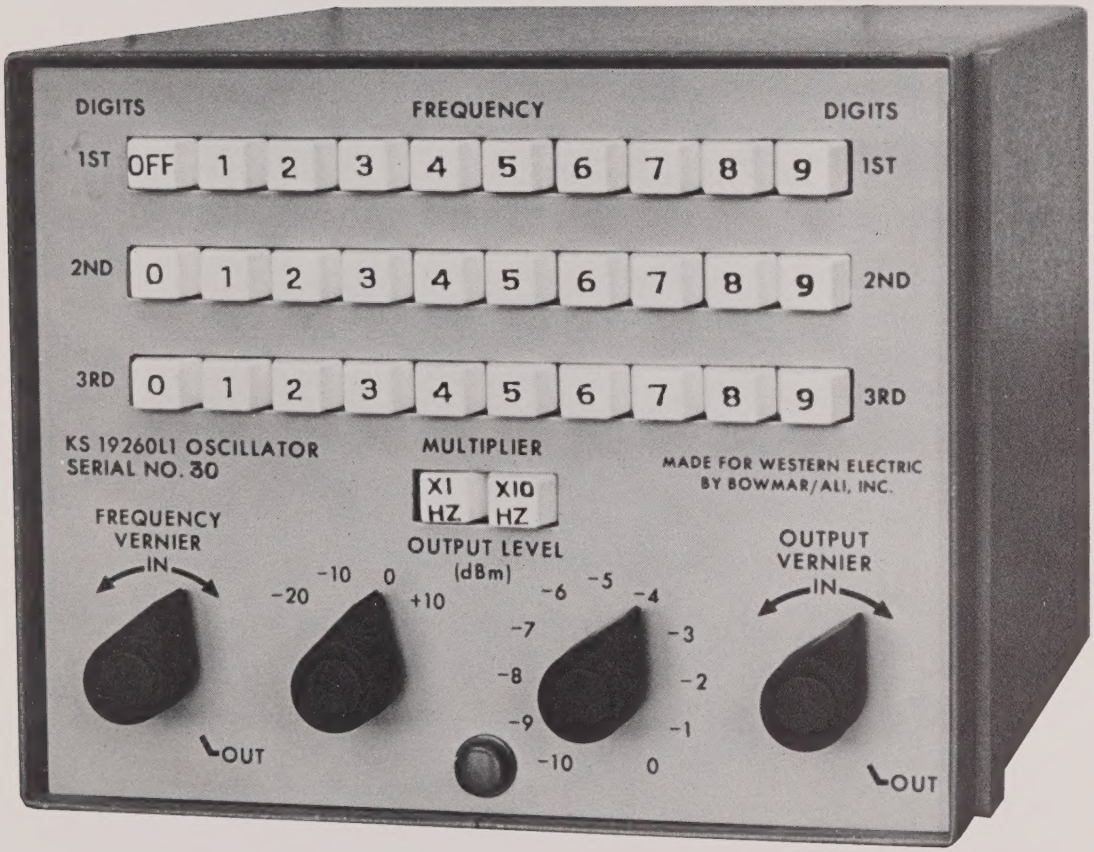
Change: from R35, 36 Resistor, 825Ω, 1/8 W, 1%
Corning RN60C8250F
to R35, 36 Resistor, 909Ω, 1/8 W, 1%
Corning RN60C9090F

List of Manufacturers

Add:

ITT

ITT Semiconductors
3301 Electronics Way
West Palm Beach, Florida 33407 USA



PUSHBUTTON OSCILLATOR
KS 19260 L1

TABLE OF CONTENTS

Section		Page
1	INTRODUCTION	1-1
	1.1 Description	1-1
	1.2 Scope of Manual	1-1
	1.3 Designation of Instruments	1-1
	1.4 Specification Summary	1-1
2	INSTALLATION AND OPERATING INSTRUCTIONS	
	2.1 Installation	2-1
	2.2 Description of Controls	2-2
	2.3 Output Level Adjustment	2-2
	2.4 Frequency Setting	2-3
	2.5 Level Setting	2-3
3	THEORY OF OPERATION	
	3.1 General	3-1
	3.2 Frequency Determining Elements	3-1
	3.3 Oscillator Amplifier and AGC	3-2
	3.4 Output Amplifier	3-3
	3.5 Output Level Controls	3-3
	3.6 Power Supply and Current Limiter	3-3
4	MAINTENANCE	
	4.1 Introduction	4-1
	4.2 Test Equipment Required	4-1
	4.3 Cabinet Removal	4-1
	4.4 Performance Checks	4-1
	4.5 Calibration and Alignment	4-7
5	TROUBLESHOOTING	
	5.1 Checklist in Event of Unsatisfactory Operation	5-1
	5.2 No Output from Unit	5-1
	5.3 Excessive Distortion	5-1
	5.4 Incorrect Levels	5-2
	5.5 Incorrect Frequency	5-2
6	DRAWINGS	
	6.1 General	6-1
	6.2 List of Drawings	6-1
7	PARTS LIST	
	7.1 General	7-1
8	SUPPLEMENTARY DATA	
	8.1 Guarantee	8-1
	8.2 Material Damaged in Shipment	8-1

1.0 GENERAL

1.1 Description

The KS-19260 is an all solid state, voice frequency, pushbutton oscillator offering high accuracy in frequency and output level. It has a balanced and floating output of either 600 or 900 ohms impedance, and is designed to operate from a 48 V dc source.

The unit will generate frequencies in 1 Hz steps from 100 Hz to 1000 Hz and in 10 Hz steps from 1000 Hz to 9990 Hz. The accuracy of the frequency generated, with the FREQUENCY VERNIER in the OUT (detented) position, is ±.2%. The FREQUENCY VERNIER allows continuous coverage between frequency steps and extends the range to 10,000 Hz.

Output of the unit, delivered to either a 600 or 900 ohm load, is -30 dBm to +10 dBm. The output can be varied in 1 dB steps over this range by use of the OUTPUT LEVEL controls. The accuracy of the output is ±.2 dB with the OUTPUT VERNIER in the OUT (detented) position. The OUTPUT VERNIER has a range of approximately 1.25 dB.

1.2 Scope of Manual

This manual covers the installation and operation of the oscillator, including routine maintenance, calibration, alignment, and troubleshooting. The text is supplemented by detailed schematics, component locating diagrams, and a list of electrical components with the names and addresses of manufacturers.

1.3 Designation of Instruments

KS-19260 L1 designates the oscillator designed for direct installation in a 7 x 7-1/4 inch relay rack. KS-19260 L4 designates the oscillator identical to the L1 with the addition of mounting brackets for a bay framework installation.

1.4 Specification Summary

Frequency:	100 Hz to 10 kHz, 2 ranges
Frequency Response:	Within ± 0.2 dB over entire range
Frequency Accuracy:	Within ± 0.2% from 55° to 95° F; within ± 0.3% from 45° to 55° F and 95° to 105° F with FREQUENCY VERNIER in OUT (detented) position
Output Power:	+10 to -30 dBm in 1 and 10 dB steps; OUTPUT VERNIER range is at least 1 dB and not more than 1.5 dB

Output Power Accuracy:	±0.2 dB of indicated value when correctly terminated in either 600 or 900 ohms with OUTPUT VERNIER in OUT (detented) position; including effects of frequency response, input voltage changes, temperature of 55° to 95° F and relative humidity of 10% to 95%
Output Stability:	Within ± 0.1 dB for at least 3 hours, temperature within ± 5° F
Distortion:	At least 40 dB below fundamental output
Noise:	At least 65 dB below total output
Output Impedance:	600 and 900 ohms, ±5%, selectable; maximum phase angle of ±5°
Output Circuit:	Will withstand 500 V dc between any output terminal and the chassis ground
Balance:	At least 70 dB at 100 Hz; 55 dB at 3000 Hz
Input Power:	48 ± 4 V dc; positive side grounded; approximately 200 mA current drain
Weight:	8- 1/2 pounds
Dimensions:	8- 1/32 inches wide, 6- 3/32 inches high, 8 inches deep

2.0 INSTALLATION AND OPERATING INSTRUCTIONS

2.1 Installation

.1 The KS-19260 L1 oscillator is designed for direct installation in a 7-3/4 inch relay rack. The mounting bars at the side of the instrument are held by four WECo #16 jack fasteners, which are furnished with the set. When the oscillator is to be installed in 19 or 23 inch relay racks, a special mounting plate is required; for 19 inch racks, the KS-19260 L2 mounting plate is used, and the KS-19260 L3 mounting plate is used for 23 inch racks. The oscillator is fastened to the plate with the jack fasteners.

The KS-19260 L4 oscillator is identical to the L1 oscillator except that the outer cover has attached brackets to accommodate mounting in bay framework adapters with KS-19260 L5 mounting plates.

.2 Power and Output Connections

A dc power source of -48 ±4 V should be connected to the proper terminals on the rear of the oscillator. (See FIG. 2-A.) Use the fanning strip furnished with the set.

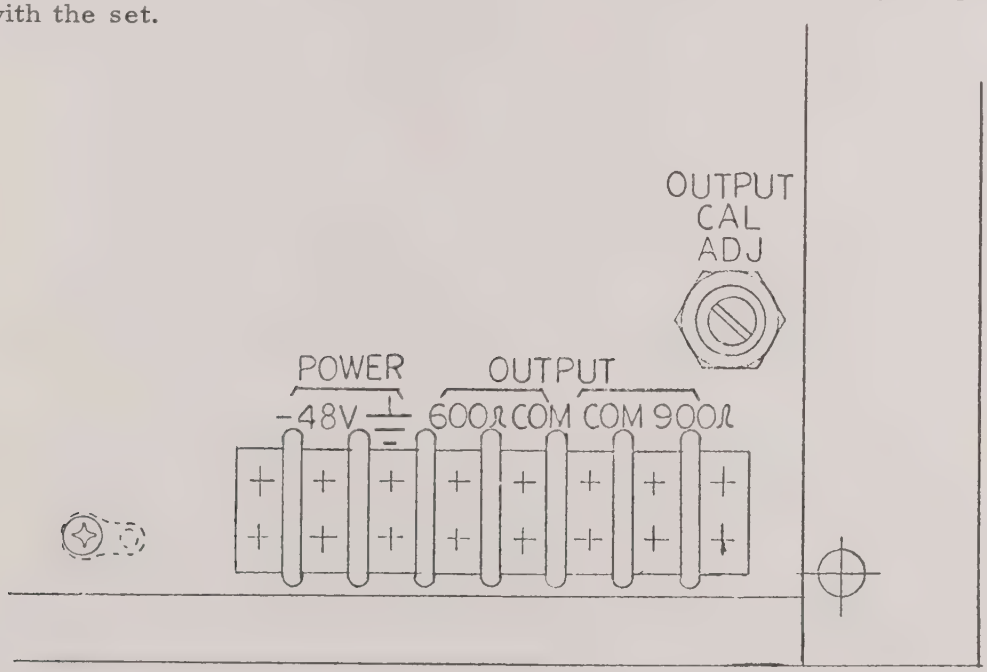


FIG. 2-A

Connect the circuit under test to either the 600 Ω or 900 Ω OUTPUT terminals on the rear of the set. (See FIG. 2-A above.) Do not connect load circuits to both the 600 Ω and 900 Ω terminals at the same time.

Note: When the load circuit presents a dc voltage across it, a blocking capacitor should be provided in series with the output to prevent damage to oscillator components. A 20 microfarad capacitor will cause negligible error over the entire frequency range.

2.2 Description of Controls

.1 FREQUENCY

This control consists of three decks of pushbutton switches, ten switches per deck. The 1ST DIGIT row, the top deck of the control, is labeled 1 through 9 with an OFF position. When the oscillator has an appropriate power source of -48 ± 4 V dc applied to the power terminals in the rear, the actuation of any digit 1 through 9 in the 1ST DIGIT row will turn on the oscillator; depressing the OFF button removes the power from the oscillator. The 2ND DIGIT and 3RD DIGIT rows are labeled 0 through 9. The three decks of the FREQUENCY control, in conjunction with the MULTIPLIER, and the FREQUENCY VERNIER control, determine the output frequency of the oscillator.

.2 MULTIPLIER

The MULTIPLIER consists of two pushbutton switches which select either X1 Hz or X10 Hz multiplication of the frequency indicated on the FREQUENCY control.

.3 FREQUENCY VERNIER

The FREQUENCY VERNIER control consists of a potentiometer with an OUT (detented) position at the extreme clockwise rotation. This control varies the output frequency approximately ± 2% from the nominal value. It is extremely important that it be used properly if erroneous frequency settings are to be avoided.

.4 OUTPUT LEVEL (dBm)

The OUTPUT LEVEL (dBm) control consists of two switched attenuators; one provides for attenuation in 1 dB steps of 0 through -10 and the other provides for attenuation in 10 dB steps of -20, -10, 0, +10. When the OUTPUT VERNIER is in the OUT (detented) position, the output level of the oscillator will be within ±.2 dB of the value indicated by the OUTPUT LEVEL (dBm) controls.

.5 OUTPUT VERNIER

The OUTPUT VERNIER control consists of a potentiometer with an OUT (detented) position at the extreme clockwise rotation. It provides a range of approximately 1.25 dB. It must be kept in the detented position if the output of the unit, as indicated by the OUTPUT LEVEL (dBm) controls, is to be maintained within the stated accuracy of ±.2 dB.

2.3 Output Level Adjustment

The output level was properly adjusted before the oscillator was shipped. In order to be sure that this adjustment has not been disturbed, it should be checked and re-adjusted as necessary before placing the oscillator in service. This should be done at 1000 Hz, 600 Ω impedance, and 0 dBm output power level according to the procedure below.

.1 Set the front panel controls as follows:

1ST DIGIT	1
2ND DIGIT	0
3RD DIGIT	0
MULTIPLIER	X10 Hz
FREQUENCY VERNIER	OUT (detented)
OUTPUT LEVEL (dBm)	Both at 0
OUTPUT VERNIER	OUT (detented)

.2 Connect the 600 Ω OUTPUT terminals on the rear of the oscillator (see FIG. 2-A) to a 600 ohm power measuring device that has an accuracy of at least ±0.05 dB.

.3 The power measuring device should indicate a power close to 0 dBm. Adjust the OUTPUT CAL ADJ screwdriver-operated control on the rear of the oscillator (see FIG. 2-A) for a power level reading of exactly 0 dBm.

2.4 Frequency Setting

Frequency is set by depressing the appropriate 1ST, 2ND, and 3RD DIGIT pushbuttons on the FREQUENCY control and either the MULTIPLIER X1 Hz or X10 Hz pushbuttons. For example, a frequency of 121 Hz would be set by depressing 1 on the 1ST DIGIT row, 2 on the 2ND DIGIT row, and 1 on the 3RD DIGIT row, with X1 Hz depressed on the MULTIPLIER; 1210 Hz would be obtained by using the same settings as above on the FREQUENCY control, but with the X10 Hz MULTIPLIER pushbutton depressed. In this way, frequencies from 100 Hz to 999 Hz may be obtained with 1 Hz resolution and frequencies from 1000 Hz to 9990 Hz may be obtained with 10 Hz resolution.

The FREQUENCY VERNIER must be in the OUT (detented) position to obtain an indicated frequency accuracy within ±.2%; failure to observe this precaution can lead to substantial errors since the FREQUENCY VERNIER has a range of approximately ±2%. When the FREQUENCY VERNIER is used to set a frequency between the steps available on the FREQUENCY control, it is necessary to use a suitable frequency counter to monitor the setting. For example, with the frequency counter connected to the oscillator output, a frequency of 1576 Hz is attained by depressing the 1 on the 1ST DIGIT row, the 5 on the 2ND DIGIT row, the 7 on the 3RD DIGIT row, the X10 Hz MULTIPLIER, and adjusting the FREQUENCY VERNIER until the desired frequency of 1576 Hz is indicated on the counter. Use the FREQUENCY VERNIER to extend the frequency of the oscillator to 10 kHz.

2.5 Level Setting

The level of power delivered to a matched load, in dB referenced to 1 mW, is indicated directly by the OUTPUT LEVEL (dBm) controls when the OUTPUT VERNIER is in the OUT (detented) position. For example, if the 10 dB step control is set to -10 and the 1 dB step control is set to -2, the output delivered to a matched load will be -12 ±.2 dBm. The range of the OUTPUT VERNIER is 1.25 dB nominal, and should be used when it is necessary to set up a level between the 1 dB steps. An external power meter of proper impedance must be connected to the appropriate output terminals.

3.0 THEORY OF OPERATION

3.1 General

The KS-19260 is a solid state Wien oscillator, illustrated in block diagram form in FIG. 3-A below.

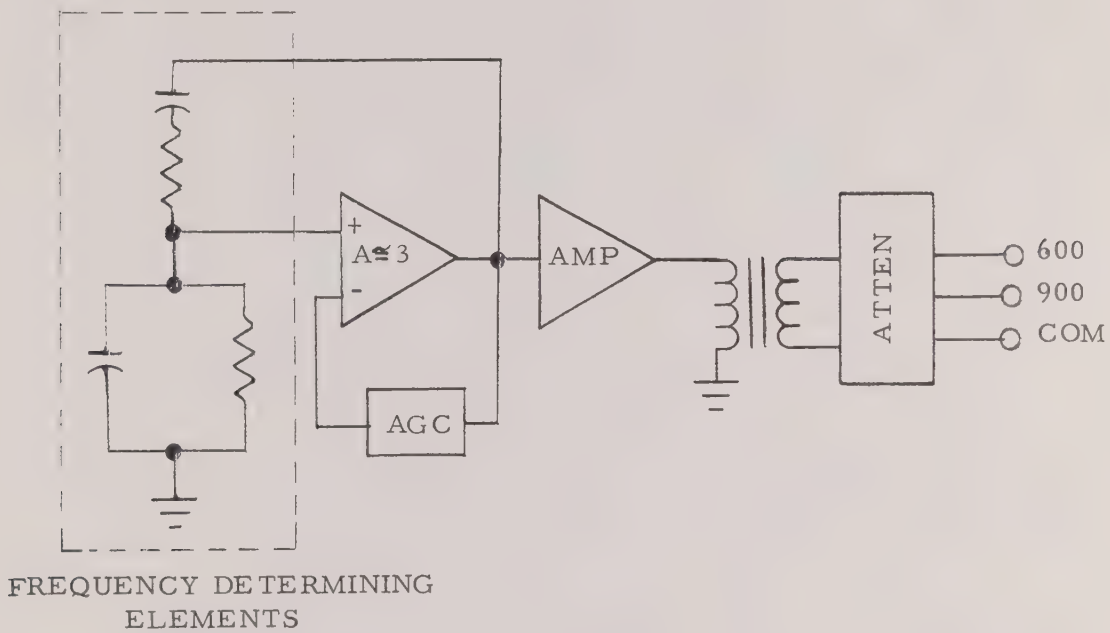


FIG. 3-A

The amplifier consists of a high input impedance stage set to provide a gain slightly in excess of 3, the minimum value required for oscillation, which is controlled by an AGC system to give a stable low distortion output. An output stage provides power through an output transformer and attenuator.

3.2 Frequency Determining Elements

The basic configuration and transfer function of the Wien feedback network is illustrated in FIG. 3-B. Note that the amplitude transfer function has a maximum value of 1/3 at the "resonant" point of the network, where the phase shift equals zero. A leading phase shift is introduced by the network at frequencies below this point and a lagging phase shift occurs at higher frequencies; therefore, when this network is used to introduce feedback around an amplifier with a gain of slightly more than 3 and phase shift of 0°, the circuit will oscillate at frequency f_o. The amplifier and AGC combination is designed to fulfill this requirement so that the frequency may be controlled conveniently by varying the RC combinations of the frequency determining network. Frequency selection is accomplished by using

precision resistors, switched in by means of three rows of pushbutton switches. To control frequency over each decade, 100-999 Hz or 1000-9990 Hz, capacitors are switched in by the decade multiplier, X1 Hz or X10 Hz. The complete schematic for the oscillator is shown in Main Schematic, 6.2.13.

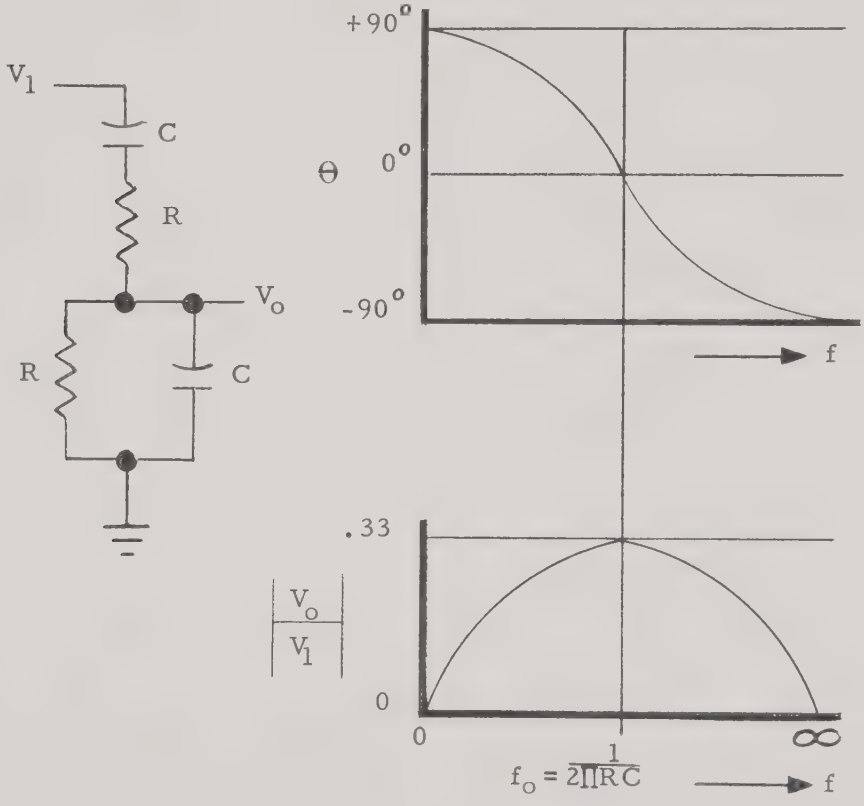


FIG. 3-B

3.3 Oscillator Amplifier and AGC (See page 6.2.2)

Transistors Q1 and Q2 are connected to form a complementary emitter follower which provides a high input impedance for the RC frequency determining network. Q3 is a gain stage with negative feedback coupled into the emitter through the emitter follower Q4. The amount of negative feedback is determined by the voltage divider R10 and CR6-CR11, R35, R36. Q5 is a gain stage which drives the class AB output stage Q6 and Q7. AGC is performed by detecting the output level of the oscillator and comparing it by the differential amplifier Q12, Q13 to a temperature-compensated Zener diode CR5. The current through diodes CR6-CR11 produces a dynamic resistance in which any change in current produces a change in the resistance ratios in the voltage divider as previously explained. This keeps the amplifier gain slightly greater than 3, the gain necessary to produce oscillation.

3.4 Output Amplifier (6.2.2)

The amplifier Q8, Q9, Q10, Q11 produces an initial high open loop gain. Negative feedback through R29 and R30 to the emitter of Q8 sets the closed loop gain for approximately 2 providing stability, low distortion, and appropriate level for the output and attenuators.

3.5 Output Level Controls

The power output controls consist of constant impedance T or bridged T attenuator sections which are switch-selected according to the desired output level. The 1 dB attenuator is made up of four T sections of 1, 2, 3, or 4 dB of attenuation, which are selected individually or summed together to provide 10 dB of attenuation in 1 dB steps. The 10 dB attenuator is made up of three bridged T sections of 10, 20, and 30 dB, which are individually selected. The adjustable level controls are variable bridged T pads, and the 600 ohm and 900 ohm impedances are determined by minimum loss matching pads.

3.6 Power Supply and Current Limiter (6.2.4)

Voltage regulation to -30V is obtained through the action of CR2 and Q3 which control the collector-to-emitter voltage drop across the Darlington coupled pair, Q1 and Q2. If the voltage at the emitter of Q2 decreases, the voltage at the base of Q3 also decreases, resulting in more base current for Q1 and Q2 and drops the collecter to emitter voltage.

The complementary series connected transistors, Q5 and Q6 are used to derive the -15 volt supply voltage used as a reference in the oscillator and output amplifiers. Q4 provides regulation to maintain the output at -15 volts by virtue of the voltage fed back through R6.

The current limiter consists of a Darlington coupled pair Q7 and Q8 which senses the voltage drop across R36 and references this voltage drop to the voltage across CR8, CR9 and CR10. This allows transistor Q8 to be turned on enough to allow only the amount of current determined by these two voltage drops. CR6 and CR7 assure a minimum collector to base voltage. CR5 eliminates damage from possible reversal of battery polarity.

4.0 MAINTENANCE

4.1 Introduction

This section contains maintenance and service information for the KS-19260 Oscillator; Performance Checks, and Calibration and Adjustment Procedures, are included.

4.2 Test Equipment Required

The test equipment required for the maintenance of the oscillator is outlined in Table I; listed are the types of equipment to be used, the critical specifications, and the recommended commercially available units.

4.3 Cabinet Removal

To remove the oscillator from its case:

.1 Depress the OFF switch and, where possible, turn off power source; then remove the fanning strip from the rear terminal.

.2 Remove the four #4 retaining screws from the rear panel and slide the oscillator from its case.

4.4 Performance Checks

The performance checks are to be performed with the oscillator in its case. These procedures are designed to be used for periodic maintenance, quality control checks, and to verify the general performance of the oscillator after calibration.

.1 Frequency Accuracy

A frequency counter, General Radio 1192; a level meter, and a power supply, Hewlett-Packard 6206B; or equivalents, are needed to perform these measurements.

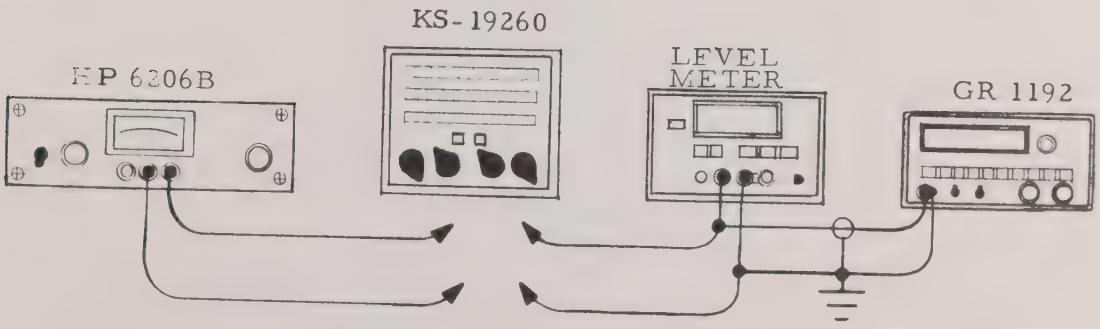


FIG. 4-A

TEST EQUIPMENT REQUIRED

INSTRUMENT TYPE	REQUIRED CHARACTERISTICS	USE	RECOMMENDED MODEL
Frequency Counter	Frequency Range: dc to 30 MHz Accuracy: ±0.3% of one period ÷number of periods averaged Stability: $\pm 2 \times 10^{-6}$ per month	Frequency Accuracy Frequency Vernier	General Radio 1192
Level Meter	Frequency Range: 100 Hz to 50 kHz Accuracy: ±0.01 dB ±1 digit	Output Level Accuracy Output Cal Adj Range Output Vernier Range	
Distortion Analyzer	Frequency Range: 5 Hz to 600 kHz Fundamental Rejection: 80 dB	Longitudinal Balance Distortion Noise Output	Hewlett-Packard 334A
Impedance Bridge	Resistance Range: (series) 0.05 mΩ to 1.1 MΩ Q: (of series resistance) 0.0005 to 1.2 inductive at 1 kHz Accuracy: ±0.05% ±.005% of full scale at 1 kHz	Output Z	General Radio 1608-A
DC Power Source	Range: 0 to 60 V, .5 A Line Regulation: 0.01% +4 mV	Frequency Accuracy Output Level Accuracy Distortion Output Cal Adj and Output Vernier Frequency Vernier Longitudinal Balance Noise Output	Hewlett-Packard Harrison 6206B

TABLE I

.a With the test set-up shown in FIG. 4-A, and the frequency counter and level meter connected to the 600 Ω OUTPUT of the oscillator, set the controls on the level meter for a 600 ohm termination.

.b Set FREQUENCY control to 100, MULTIPLIER to X1 HZ, OUTPUT LEVEL (dBm) controls to 0, OUTPUT VERNIER to OUT, and FREQUENCY VERNIER to OUT.

.c Adjust OUTPUT CAL ADJ potentiometer, located on the rear panel, to obtain an output from the oscillator of exactly 0 dBm.

.d With the counter controls set to measure period, check the oscillator frequencies as listed inTABLE II, noting that the period measurements stay within the specified limits.

NOTE: Since many counters have an insufficient number of digits to present low-audio frequencies directly to the required accuracy, this test has been set up for period measurements; for convenience, however, where suitable counters are available, the table contains both frequency and period measurements.

Oscillator Setting-Hz	Frequency-Hz			Period-μs		
111	110.77	to	111.22	9027.06	to	8991.03
222	221.55	to	222.44	4513.53	to	4495.51
333	332.33	to	333.67	3009.02	to	2997.01
444	443.11	to	444.89	2256.77	to	2247.76
555	553.89	to	556.11	1805.41	to	1798.21
666	664.66	to	667.33	1504.51	to	1498.50
777	775.44	to	778.55	1289.58	to	1284.43
888	866.22	to	889.77	1128.38	to	1123.88
999	997.00	to	1000.99	1003.01	to	999.00
1110	1107.7	to	1112.2	902.71	to	899.10
2220	2215.5	to	2224.4	451.35	to	449.55
3330	3323.3	to	3336.7	300.90	to	299.70
4440	4431.1	to	4448.9	225.68	to	224.78
5550	5538.9	to	5561.1	180.54	to	179.82
6660	6646.6	to	6673.3	150.45	to	149.85
7770	7754.4	to	7785.5	128.96	to	128.44
8880	8862.2	to	8897.7	112.83	to	112.39
9990	9970.0	to	10009.9	100.30	to	99.90

TABLE II

.2 Output Level and Frequency Response

A level meter; and a power supply, Hewlett-Packard Harrison 6206B; or equivalents, are needed to perform these measurements.

.a Set FREQUENCY controls to 100, MULTIPLIER to X10 HZ, OUTPUT LEVEL (dBm) controls to 0, OUTPUT VERNIER to OUT, and FREQUENCY VERNIER to OUT.

.b With the level meter connected to the 600 Ω OUTPUT of the oscillator, set the controls of the level meter for 600 ohm termination, see FIG. 4-A.

.c Adjust OUTPUT CAL ADJ potentiometer, located on the rear panel, to obtain an output from the oscillator of exactly 0 dBm.

.d Switch the 10 dB step OUTPUT LEVEL control to the +10 position; the level meter must read +10 dBm ± 0.2 dB.

.e Switch the 10 dB step OUTPUT LEVEL control to the -10 position; the level meter must read -10 dBm ± 0.2 dB.

.f Switch the 10 dB step OUTPUT LEVEL control to the -20 position; the level meter must read -20 dBm ± 0.2 dB.

.g Switch the 1 dB step OUTPUT LEVEL control through each of its positions, 0 to -10. The accuracy at each step will be the indicated level ± 0.2 dB. For example: -25 dBm must read -25 dBm ± 0.2 dB.

.h Repeat steps d through g at an oscillator frequency of 100 Hz and 9990 Hz.

.i Connect the level meter to the 900 Ω OUTPUT. Set the termination on the level meter to 900 ohms.

.j Reset the OUTPUT LEVEL controls to 0. The level meter must read 0 dBm ± 0.2 dB without adjustment of the OUTPUT CAL ADJ potentiometer.

.3 Distortion

A distortion analyzer, Hewlett-Packard 334A; a power supply, Hewlett-Packard Harrison 6206B; or equivalents, are needed to perform these measurements.

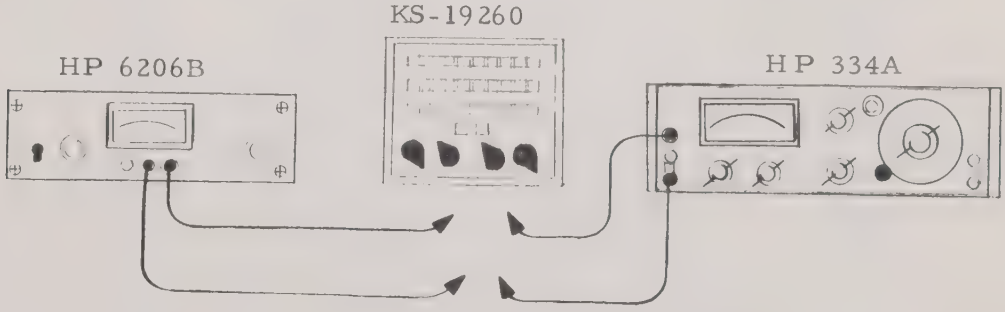


FIG. 4-B

.a Connect the distortion analyzer to the 600 Ω OUTPUT of the oscillator. See FIG. 4-B.

.b Measure the total harmonic distortion at oscillator frequencies of 100 Hz, 1000 Hz, and 9990 Hz. Total harmonic distortion at each of these frequencies must be less than -40 dB.

.4 OUTPUT CAL ADJUST and OUTPUT VERNIER

A power supply, Hewlett-Packard Harrison 6206B; or equivalent, and a level meter are needed to perform these measurements.

.a Connect the level meter to the 600 Ω OUTPUT and set the OUTPUT CAL ADJ potentiometer to its full cw position. Record the output from the level meter.

.b Set the OUTPUT CAL ADJ potentiometer to its full ccw position and record the output from the level meter.

.c The difference in the levels of step .a and step .b must be at least 1 dB but not greater than 1.5 dB.

.d Repeat steps .a through .c using the OUTPUT VERNIER control.

.5 FREQUENCY VERNIER

A power supply, Hewlett-Packard Harrison 6206B; a frequency counter, General Radio 1192; or equivalents, are needed to perform these measurements.

.a Connect the frequency counter to the 600 Ω OUTPUT and set the controls to read frequency.

.b Set FREQUENCY control to 100 and the MULTIPLIER to X1 HZ.

.c Rotate FREQUENCY VERNIER control to the maximum ccw position. The frequency counter should read 99 Hz or less.

.d Rotate FREQUENCY VERNIER control to the maximum cw position (not detented). The frequency counter should read 101 Hz minimum.

.e Set FREQUENCY control to 999, the MULTIPLIER to X10 HZ, and the FREQUENCY VERNIER control to maximum cw position (not detented). The frequency counter should read 10,000 Hz minimum.

.f Rotate FREQUENCY VERNIER control to the maximum ccw position. The frequency counter should read 9980 Hz or less.

.6 Longitudinal Balance

A power supply, Hewlett-Packard Harrison 6206B; a distortion analyzer, Hewlett-Packard 334A; or equivalents, two 300 Ω ± 1% resistors, two 450 Ω ± 1% resistors matched to within ± 0.1%, and a 150 Ω ± 1% resistor will be needed to perform the measurements in this test.

.a Connect the test fixture and the test gear as shown in FIG. 4-C, with the test fixture connected at the 600 Ω OUTPUT.

.b Set FREQUENCY control to 100, MULTIPLIER to X1 HZ and the OUTPUT LEVEL (dBm) to 0. Measure the output level with the distortion analyzer in the voltmeter mode for a level across the 150 Ω resistor of less than -70 dB.

.c Set FREQUENCY control to 300 and the MULTIPLIER to X10 HZ. Measure across the 150 Ω resistor for a level of less than -55 dB.

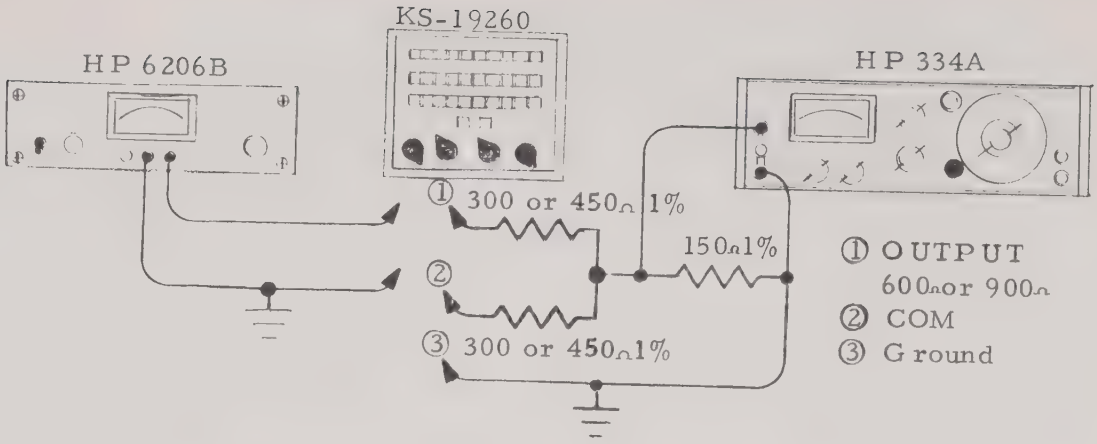


FIG. 4-C

.d Change the 300 Ω resistors to 450 Ω resistors and repeat steps .b and .c with the test fixture connected to the 900 Ω OUTPUT.

.7 Output Z (6.2.1)
An impedance bridge, General Radio 1608-A, or equivalent, will be needed to perform these measurements.

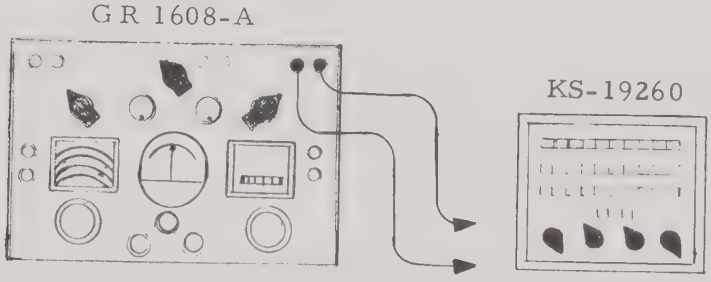


FIG. 4-D

.a Disconnect the oscillator from its power source; remove oscillator from case. Connect a clip lead from the junction of R27, R28, and C9 to chassis ground to simulate the low impedance at this point when power is applied to the oscillator and connect the impedance bridge to the 600 Ω OUTPUT. See FIG. 4-D.

.b Measure the impedance for a value of not less than 570 ohms nor greater than 630 ohms, with a Q of not more than 0.0875 (Tan 5°).

.c Reconnect the impedance bridge to the 900 Ω OUTPUT. Measure the impedance for a value of not less than 855 ohms nor more than 945 ohms, with a Q of not more than 0.0875 (Tan 5°).

.8 Noise Output
A power supply, Hewlett-Packard Harrison 6206B; a distortion analyzer, Hewlett-Packard 334A; or equivalents, and 0.01 μF 50 V capacitor and a 600 Ω 1% resistor will be needed to perform these measurements.

.a Connect the oscillator as shown in FIG. 4-B. Terminate the 600 Ω OUTPUT with a 600 Ω resistor and a 0.01 μF capacitor in parallel. Power the oscillator and, with the OUTPUT LEVEL (dBm) controls set to 0, and with neither of the MULTIPLIER buttons depressed, measure the noise level at the 600 Ω OUTPUT. The output noise level must be less than -65 dBm.

4.5 Calibration and Alignment

.1 Recalibration Procedure

In the event that the required frequency, level and distortion requirements are not met during performance checks, it will be necessary to recalibrate the oscillator following the procedures described below.

Remove the oscillator from the case. Connect a 600 ohm load to the 600 Ω OUTPUT terminals, and a 48 ±4 V dc supply to the power input terminals. Set R30 and R33 on the Oscillator Board Assembly, 6.2.1, to approximately mid-range. Depress the X1 Hz MULTIPLIER, the 1 on the 1ST DIGIT row and the 0 on the 2ND DIGIT and 3RD DIGIT rows. Set the OUTPUT LEVEL (dBm) controls to +10, and the OUTPUT VERNIER and FREQUENCY VERNIER to OUT (detented) positions. Adjust the OUTPUT CAL ADJ control on the rear panel until the voltmeter reads approximately +10 dBm or 2.45 V rms. Examine the dc voltages at test points E1 and E4 on the power supply assembly (referenced to chassis); they should be -30 ±3V and -15 ± 1.5 V respectively and should be essentially independent of the power supply voltage when the power supply is varied ± 4 V from the nominal 48 V. The unit is now ready for calibration.

.2 Calibration of X1 Range

Disconnect the wire leads connected to E5 and E3 on the 1st Digit Frequency Switch Assembly, 6.2.5. Depress the X1 Hz MULTIPLIER, the 2 on the 1ST DIGIT row, and the 0 on the 2ND DIGIT and 3RD DIGIT rows. The frequency should read near 100 Hz. (NOTE: With wire leads of E5 and E3 disconnected, all frequencies will be 100 Hz lower than indicated by the FREQUENCY and MULTIPLIER pushbuttons. Select capacitors C4A, C4B and C5A, for a reading of 100.0 ± .04 Hz. Step through the 1ST DIGIT numbers, noting that frequencies 200 through 800 Hz are within the .2% accuracy specifications.

Reconnect the wire leads to E5 and E3. Depress the 1 on the 1ST DIGIT row. The frequency should again read near 100 Hz. Select resistors R62 and R63 on the 1st Digit Frequency Switch Assembly, 6.2.5, for a frequency reading of 100.0 ±0.04 Hz. The calibration of X1 range should now be complete. Recheck all frequencies, 1ST DIGIT row, 100 through 900 Hz, for the required accuracy of ± .2%.

NOTE: When disconnecting or connecting wire leads and soldering in select components, power (-48 V) should be turned off.

.3 Calibration of X10 Range

Depress the X10 Hz MULTIPLIER and check the frequency at 2 kHz. If the frequency is in error by more than ± 1 Hz, reselect capacitors C6A and C6B, C7A and C7B on the Multiplier Switch Assembly, 6. 2. 8, until the 2 kHz frequency is 2000. 0 ± 1. 0 Hz. Recheck all other frequencies, 1 kHz through 9 kHz, to insure the required accuracy of ± . 2%. The X10 range is now calibrated.

.4 Oscillator and Amplifier Level Adjustment

Connect an ac voltmeter to test point E3 on the Power Supply Assembly, 6. 2. 3. Adjust R33 on the Oscillator Board Assembly, 6. 2. 1, for an oscillator output level of 6. 0 V p-p; this level should be obtained near the mid-range point of R33. Connect the voltmeter and measure the level at test point E18 on the Power Supply Assembly. Adjust R30 on the Oscillator Board Assembly for an output level of 8. 5 V p-p; this level should be obtained near the mid-range of R30. Measure the total harmonic distortion at the same test point E18. The total harmonic distortion of frequencies of 100 Hz, 1000 Hz, and 9000 Hz should be well below -40 dB. If the harmonic distortion is marginal at 9000 Hz, increase the oscillator level R33 a few tenths of a dB and readjust R30 for a level of 8. 5 V p-p. Repeat this procedure if necessary to decrease the total harmonic distortion at the higher frequencies.

NOTE 1: C12 (6. 2. 4) is a factory selected capacitor used only if the output level decreases as frequency increases. Selection of C12 is made by referencing the output level first at 100 Hz and then selecting the appropriate value for C12 which will make the output level at 10 kHz equal to the level at 100 Hz.

NOTE 2: C2 (6. 2. 13) is a factory selected capacitor which is used to insure that the output longitudinal balance is greater than 70 dB at 100 Hz. If the longitudinal balance is less than 70 dB at 100 Hz, select C2 so that the longitudinal balance is greater than 70 dB at 100 Hz. The selection should be done with output level dBm controls set for +10 dBm.

.5 Final Adjustment

Replace the oscillator chassis in the case. Connect a 600 ohm 0.5% non-inductive load to the 600 Ω OUTPUT. With the power source set to -48 ± 4 V dc, set the output frequency to 1000 Hz. Connect an ac voltmeter, with an accuracy of ± .05 dBm, across the 600 ohm termination and adjust the OUTPUT CAL ADJ to a reading of 0 dBm. Scan the frequencies from 100 Hz to 9990 Hz to insure that the output level stays within the specified accuracy of ± 0.2 dB and the frequency accuracy stays within its specified tolerances listed in the table of Par. 4. 4. 1. d.

5.0 TROUBLESHOOTING

5.1 Checklist in Event of Unsatisfactory Operation

.1 Check the primary power, -48 ± 4 V dc.

.2 Remove the external loads and substitute an appropriate terminating resistor, 600 or 900 ohms.

.3 Set up several oscillator frequencies on both MULTIPLIER ranges, X1 Hz and X10 Hz, and check the oscillator output to determine if the problem is one of overall operation, or if a particular frequency determining element is at fault.

.4 Similarly, rotate the attenuator switches to various settings to determine if the malfunction is peculiar to any particular attenuator setting.

.5 If the preceding steps fail to localize the problem, the unit should be removed from the case and power applied to the -48 V terminals. The unit should be analyzed by measuring voltages at the various points indicated on the schematic diagram. The following provides information on various likely problems.

5.2 No Output from Unit

.1 Check power supply input, -48 ± 4 V.

.2 Check voltages on the Power Supply Assembly, drawing 6.2.3; schematic 6.2.4; referenced to chassis. Test point E1 should be -30 V; test point E4 should be -15 V.

.3 Check ac voltages at emitters of Q6-Q7, and Q10-Q11, see drawing assembly 6.2.1 and schematic 6.2.2; these should be approximately 6.0 V p-p and 8.5 V p-p respectively. If these voltages are present, but output is not present, check output attenuator and output transformer.

.4 Perform a dc voltage check throughout the oscillator amplifier if there is no ac output voltage at the emitters of Q6, Q7. The faulty components should be replaced if these voltages are abnormal. Check voltages of the output amplifier if there is no output at emitters Q10, Q11.

.5 Check the oscillator level control R33 if normal dc voltages are obtained in the amplifier but no ac output voltage is observed; an incorrect setting of this control could result in no oscillation. Another possible source of difficulty is the frequency determining components and the pushbutton switches.

5.3 Excessive Distortion

.1 Realign the unit by the method outlined in Par. 4.5.4.

.2 If this procedure does not eliminate the distortion, and the indicated frequency is correct, check the dc voltages indicated on the schematic diagram. Observe wave forms and levels in the oscillator; failure of a portion of the frequency determining elements could cause excessive AGC drive.

5.4 Incorrect Levels

.1 The output level should be adjusted as outlined in Par. 4.5.5 if the overall level is incorrect. A complete analysis of the oscillator dc levels should be accomplished if this adjustment is not possible.

.2 The resistors in the attenuators should be checked if the output level is incorrect at some of the attenuator settings.

5.5 Incorrect Frequency

.1 The instrument should be calibrated as outlined in Par. 4.5.2 and 4.5.3 if all frequencies of the unit have shifted.

.2 The appropriate resistors in the frequency determining network should be checked if specific frequencies are incorrect.

6.0 DRAWINGS

6.1 General

This section contains the schematic diagrams, supplemented by component locating diagrams, necessary to assist the field engineer or technician in the maintenance, calibration, and use of this equipment.

Notes

Unless otherwise specified: resistors are in ohms, 1/2 watt, 5%, capacitors are in microfarads.

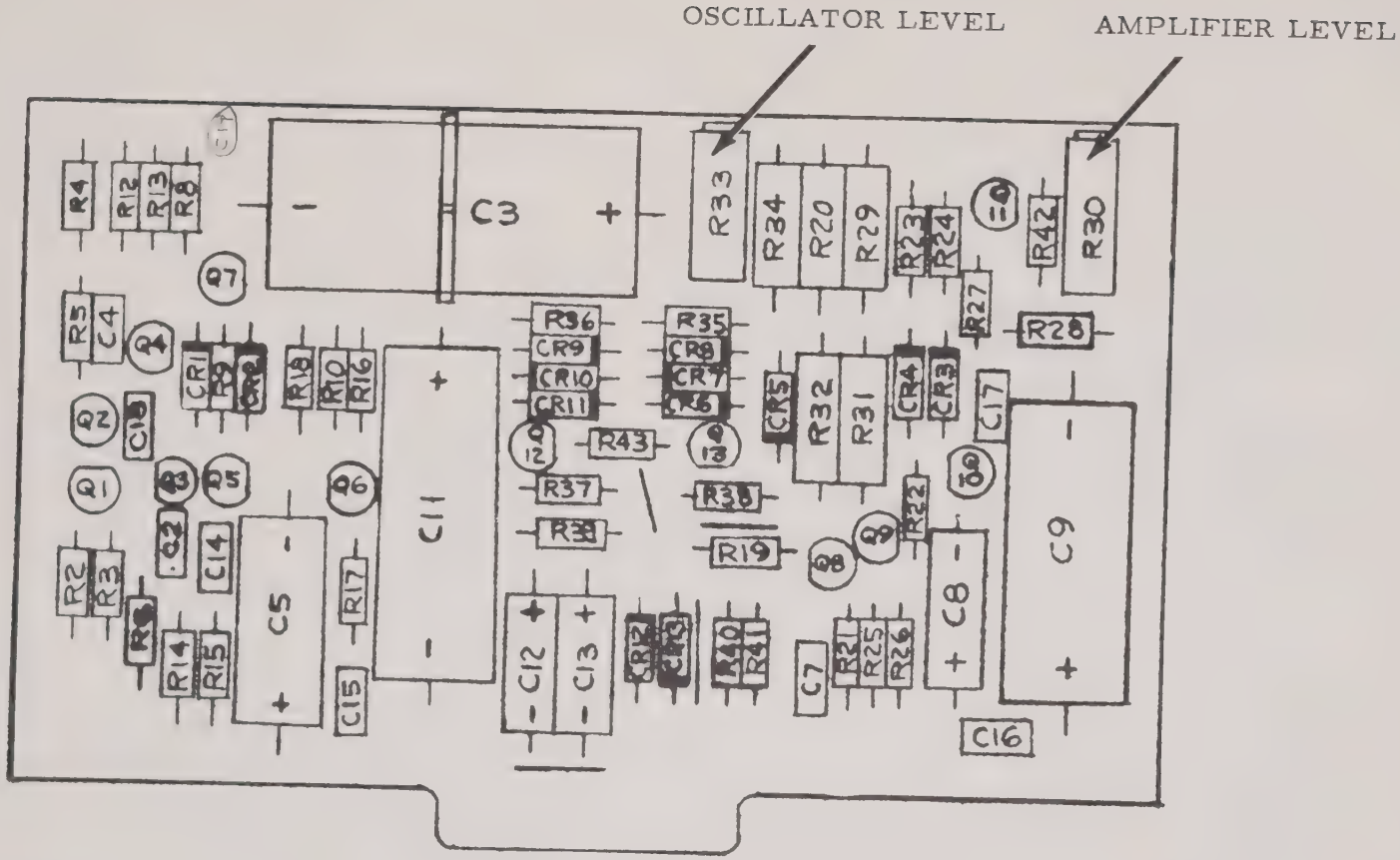
Components within broken lines (– – –) are mounted on printed circuit boards.

Nomenclature in blocks [ ] indicate front panel markings.

An asterisk * indicates values which may be trimmed during test.

6.2 List of Drawings

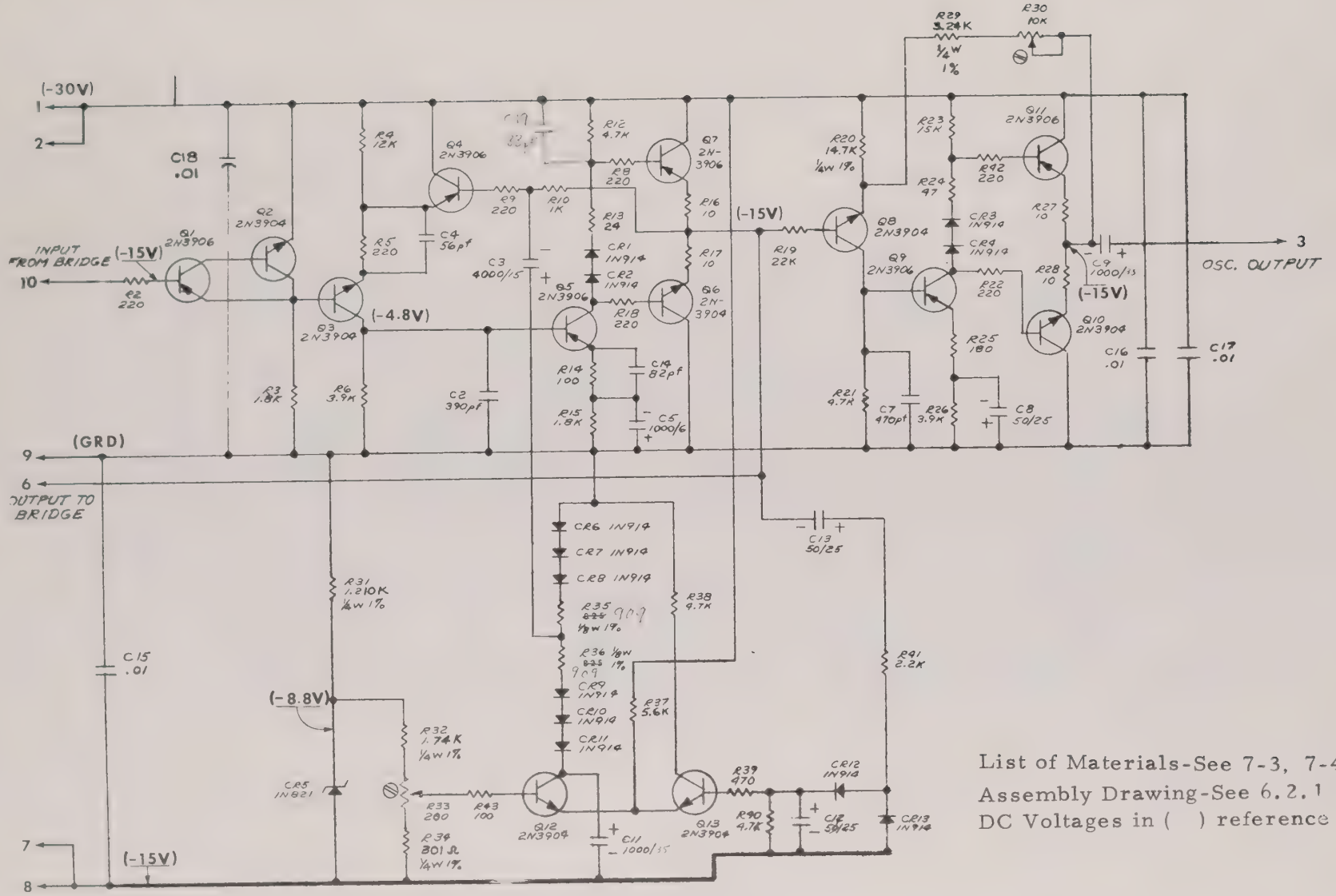
6.2.1	Oscillator Board Assembly
6.2.2	Oscillator Board Schematic
6.2.3	Power Supply Assembly
6.2.4	Power Supply Schematic
6.2.5	1st Digit Frequency Switch Assembly
6.2.6	2nd Digit Frequency Switch Assembly
6.2.7	3rd Digit Frequency Switch Assembly
6.2.8	Multiplier Switch Assembly
6.2.9	1 dB Output Level Attenuator Assembly
6.2.10	10 dB Output Level Attenuator Assembly
6.2.11	Rear Panel
6.2.12	Main Assembly
6.2.13	Main Schematic



List of Materials- See 7-3, 7-4
Schematic- See 6.2.2

PUSHBUTTON OSCILLATOR
KS-19260 L1

OSCILLATOR BOARD ASSEMBLY

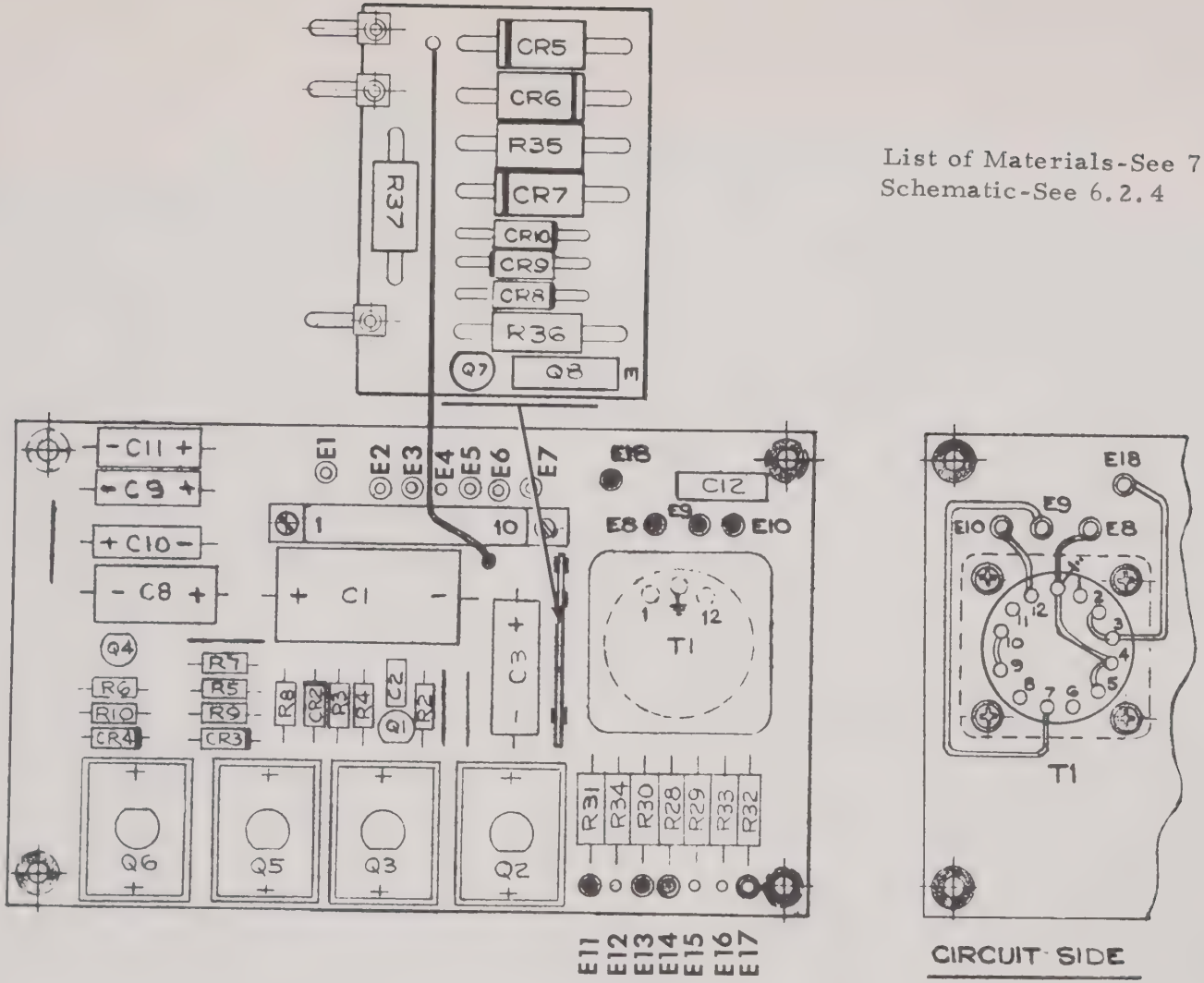


List of Materials-See 7-3, 7-4
Assembly Drawing-See 6.2.1
DC Voltages in ( ) reference chassi

PUSHBUTTON OSCILLATOR
KS-19260 L1

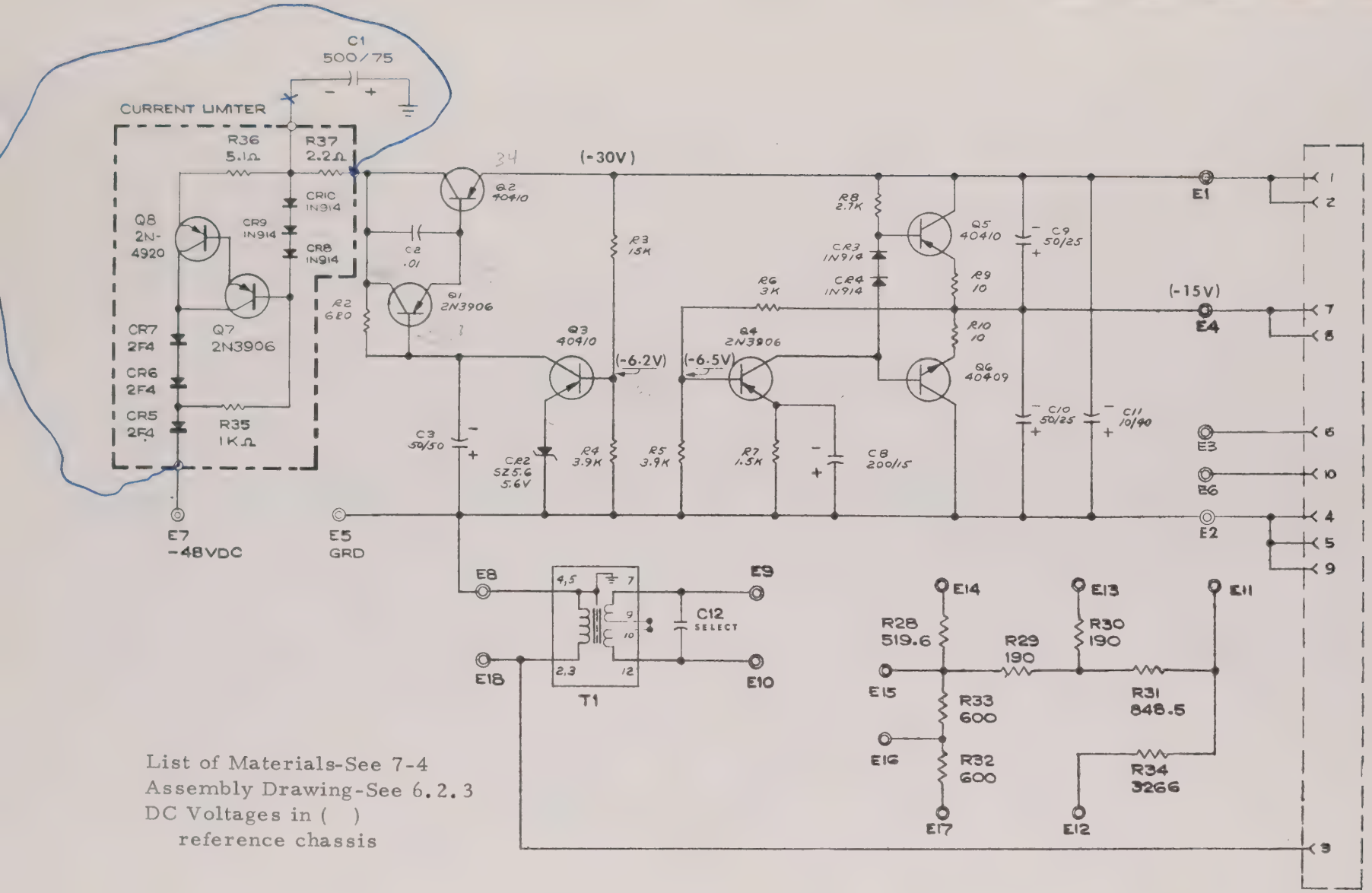
OSCILLATOR BOARD SCHEMATIC

List of Materials-See 7-4
Schematic-See 6.2.4



PUSHBUTTON OSCILLATOR
KS-19260 L1

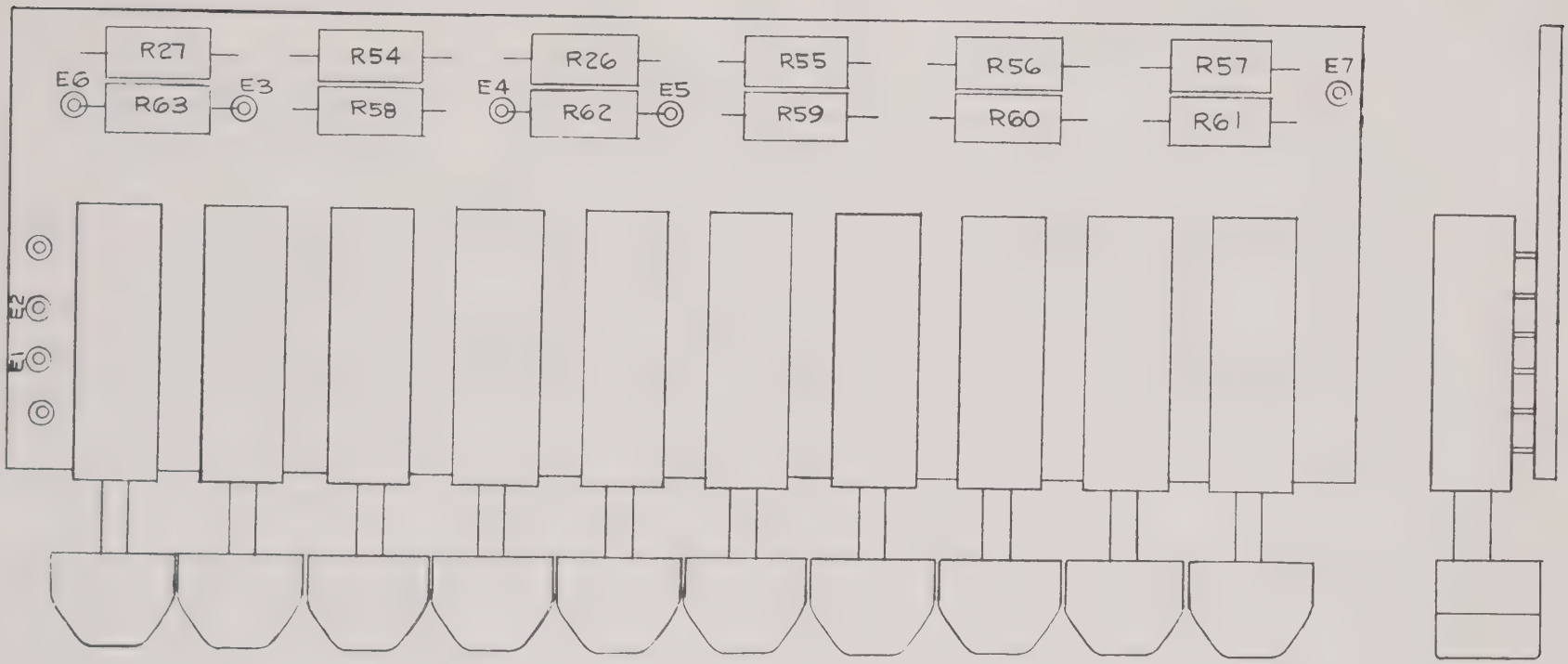
POWER SUPPLY ASSEMBLY



List of Materials-See 7-4
Assembly Drawing-See 6.2.3
DC Voltages in ( )
reference chassis

PUSHBUTTON OSCILLATOR
KS-19260 L1

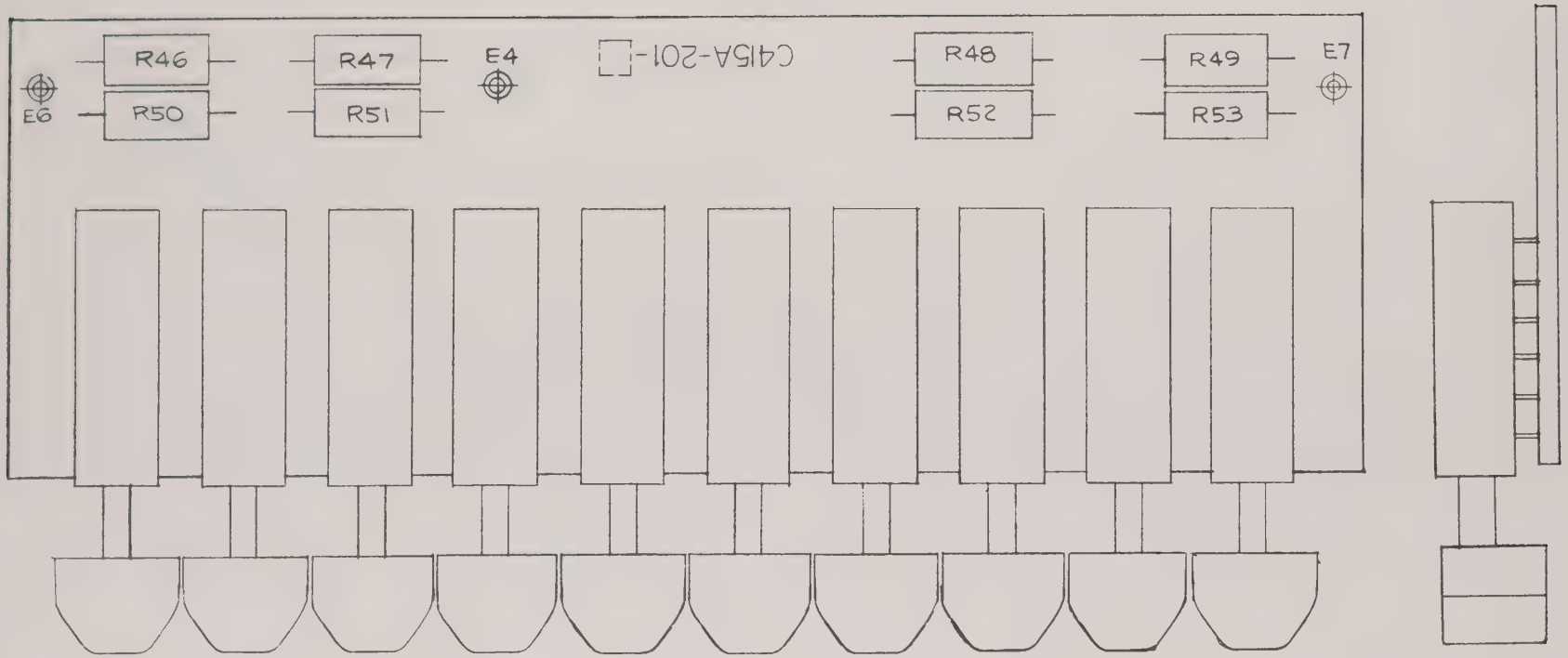
POWER SUPPLY SCHEMATIC



List of Materials-See 7-5
Schematic-See 6.2.13

PUSHBUTTON OSCILLATOR
KS-19260 L1

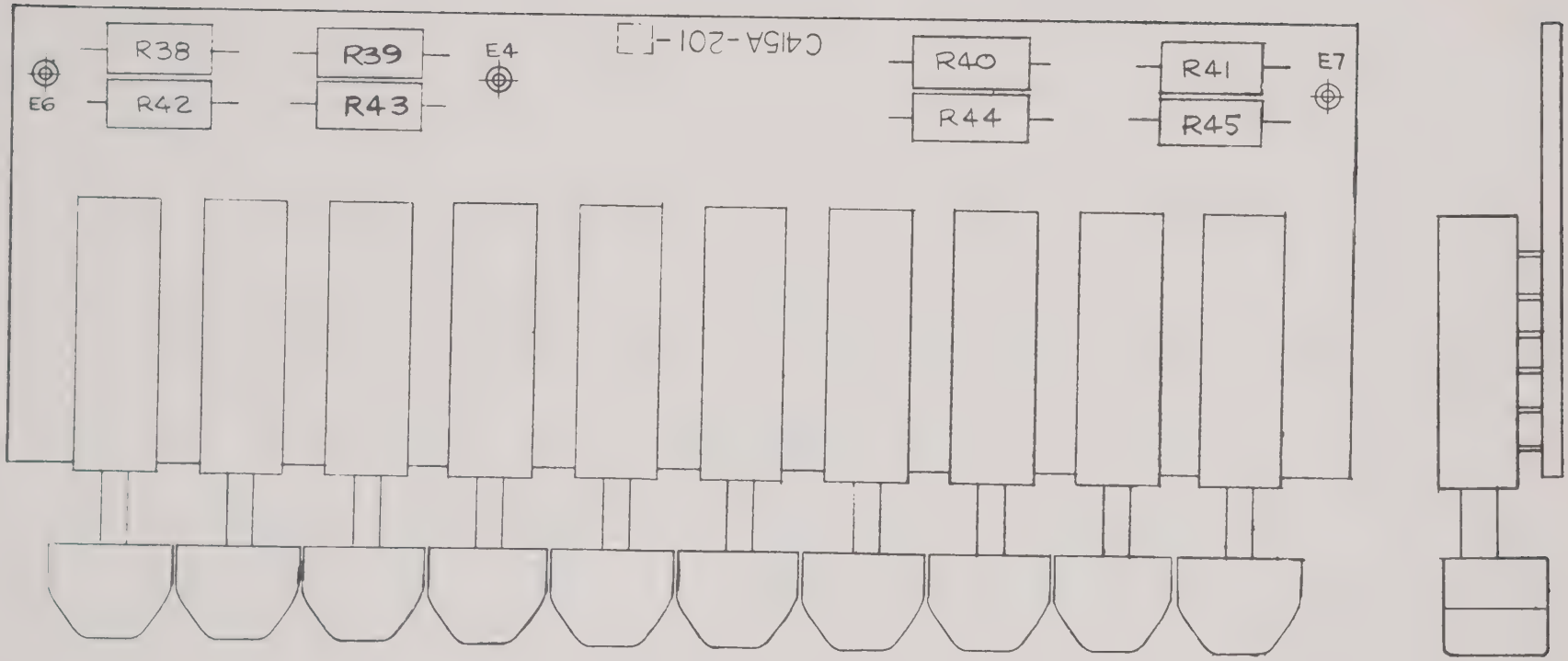
1ST DIGIT FREQUENCY SWITCH ASSEMBLY



List of Materials-See 7-5
Schematic-See 6.2.13

PUSHBUTTON OSCILLATOR
KS-19260 L1

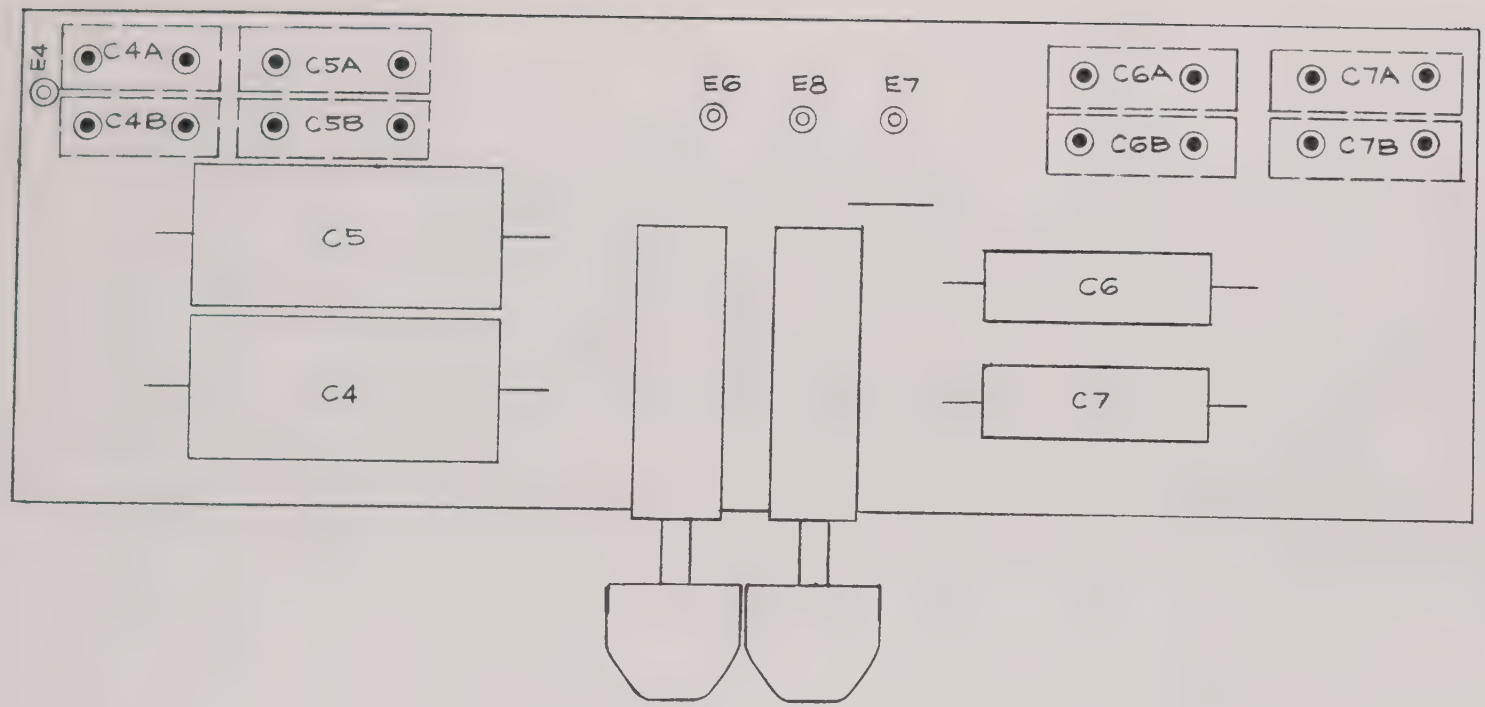
2ND DIGIT FREQUENCY SWITCH ASSEMBLY



List of Materials-See 7-5
Schematic-See 6.2.13

PUSHBUTTON OSCILLATOR
KS-19260 L1

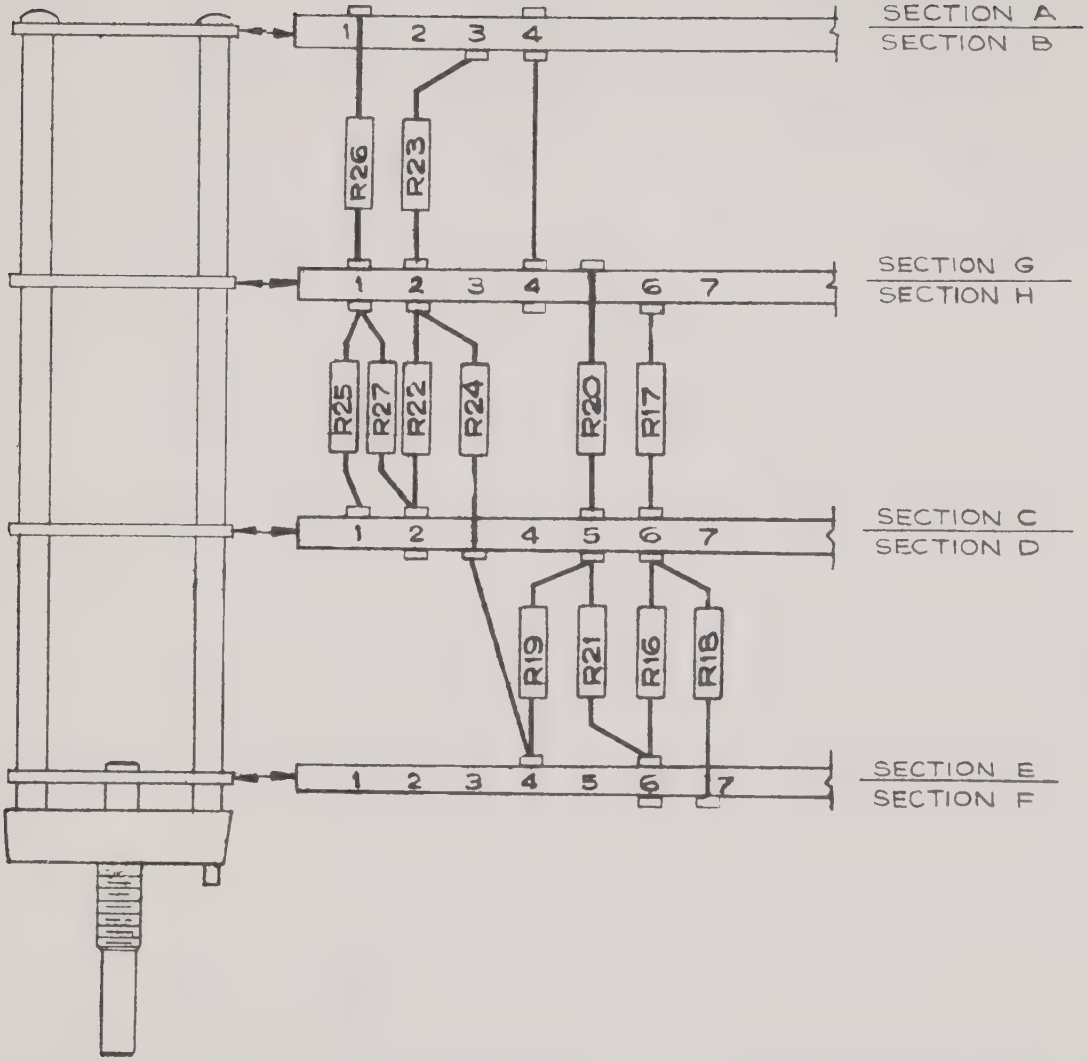
3RD DIGIT FREQUENCY SWITCH ASSEMBLY



List of Materials-See 7-6
Schematic-See 6.2.13

PUSHBUTTON OSCILLATOR
KS-19260 L1

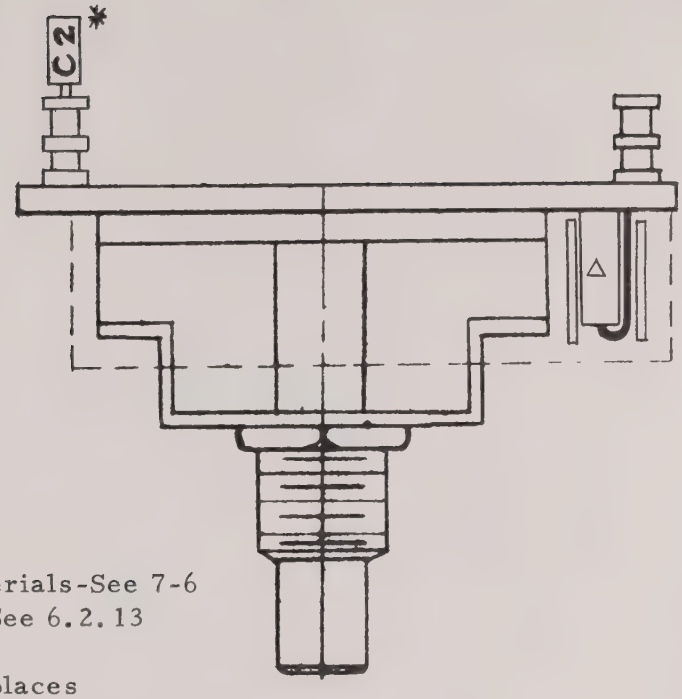
MULTIPLIER SWITCH ASSEMBLY



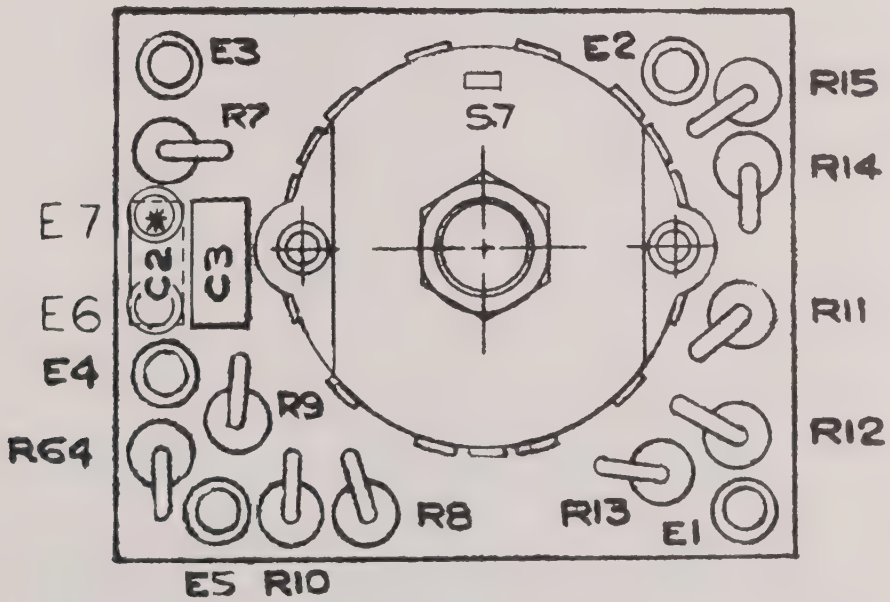
List of Materials-See 7-6
Schematic-See 6.2.13

PUSHBUTTON OSCILLATOR
KS-19260 L1

1 dB OUTPUT LEVEL
ATTENUATOR ASSEMBLY



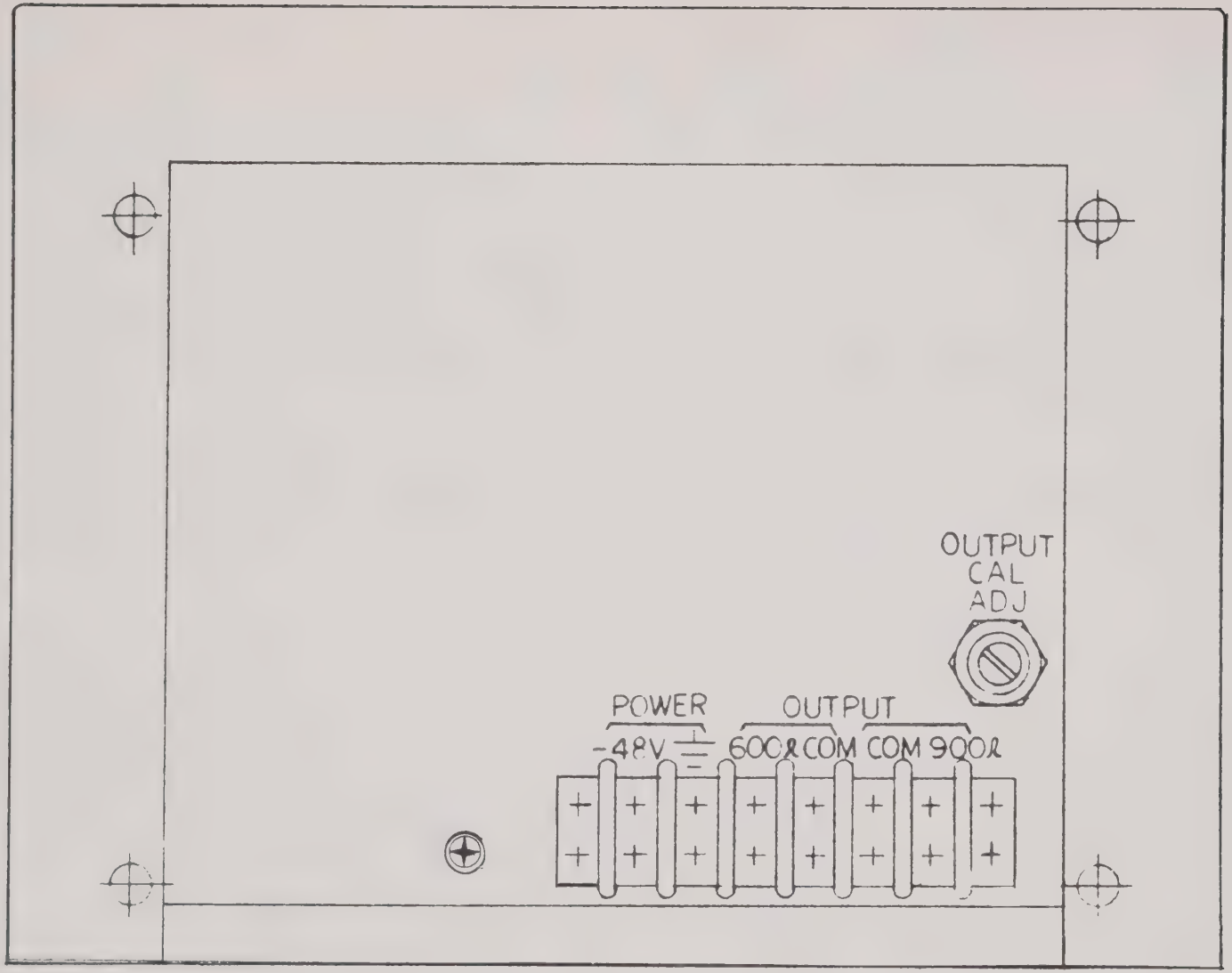
List of Materials-See 7-6
Schematic-See 6.2.13
* Selected
△ Typical 10 places



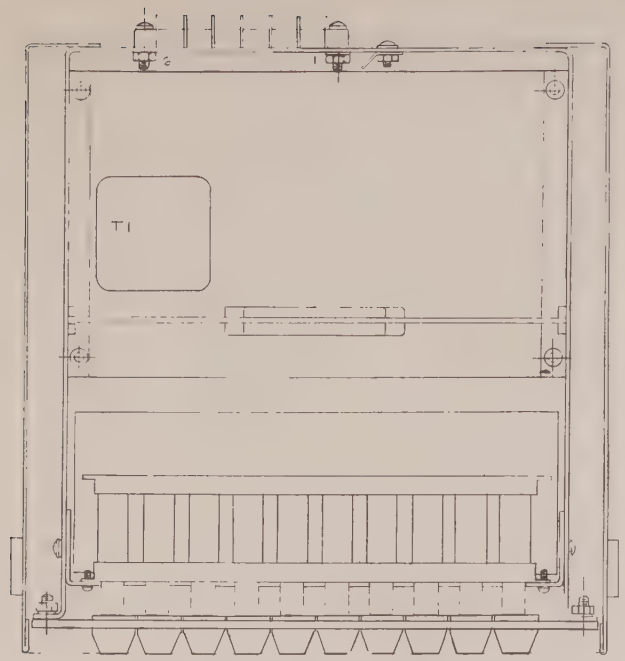
COMPONENT SIDE

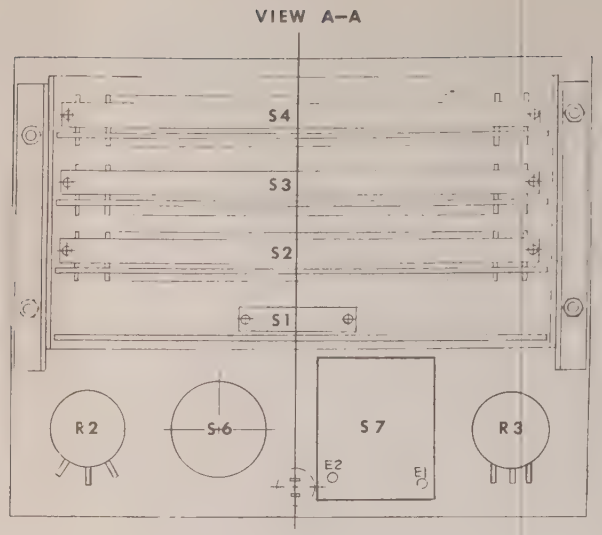
PUSHBUTTON OSCILLATOR
KS-19260 L1

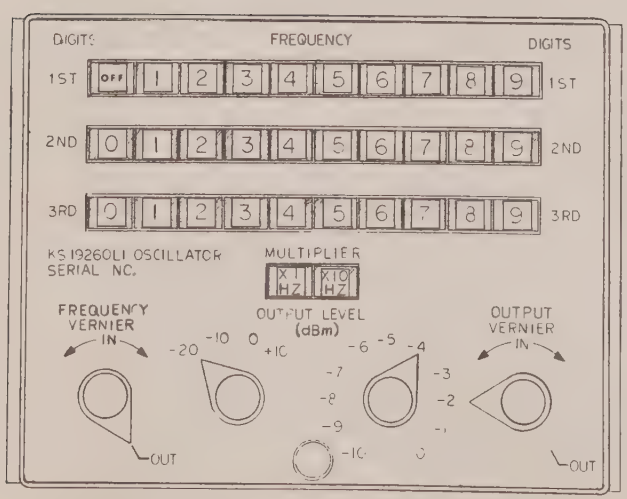
10 dB OUTPUT LEVEL
ATTENUATOR ASSEMBLY

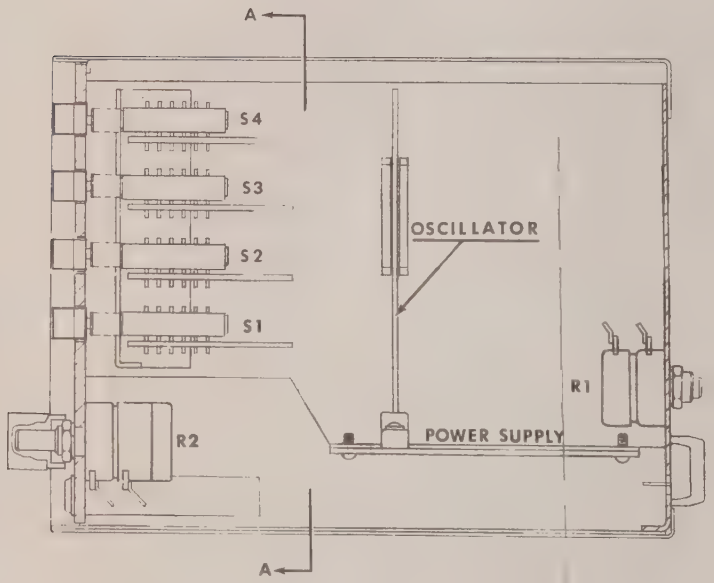


PUSHBUTTON OSCILLATOR
KS-19260 L1
REAR PANEL



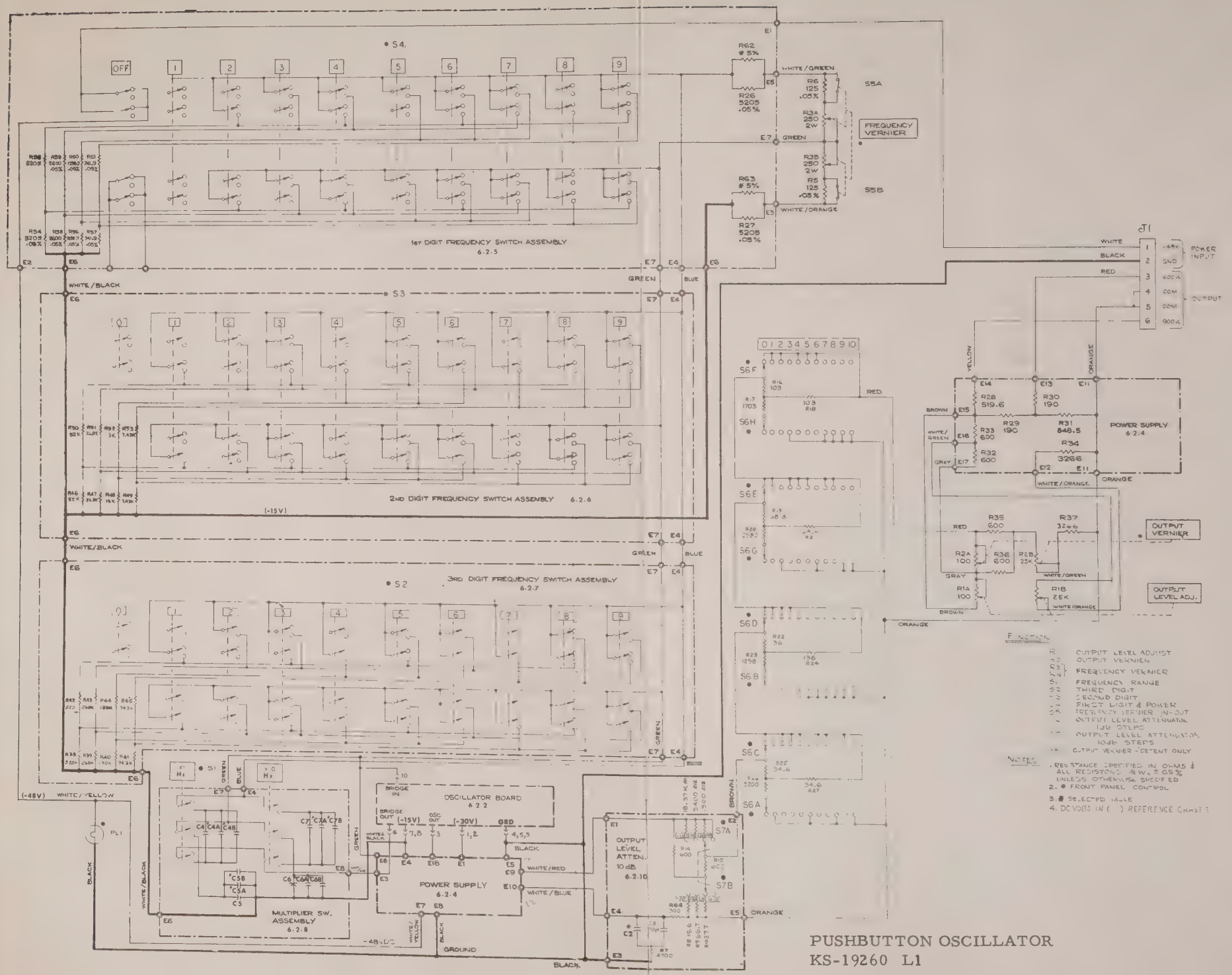






PUSHBUTTON OSCILLATOR
KS-19260 L1

MAIN ASSEMBLY



PUSHBUTTON OSCILLATOR
KS-19260 L1

MAIN SCHEMATIC

7.0 PARTS LIST

7.1 General

The parts list itemizes all electrical parts by circuit number. Certain hardware items, such as screws, washers, etc., are not included as these are identifiable and readily available. Generally, the manufacturer's name has been included; however, where the item is a standardized RETMA part, no manufacturer is designated and the product of a registered manufacturer should be acceptable.

Certain items within this parts list may have Bowmar/ALI (ALI) part numbers although they are not manufactured by Bowmar/ALI; these items are purchased to the ALI specification control drawing, as indicated in the parts list.

COMPONENT DESCRIPTION	MANUFACTURER	PART NUMBER
PUSHBUTTON OSCILLATOR COMPLETE BOARD REPLACEMENT		
Oscillator Board Assembly	ALI	C415A-203
Power Supply Assembly	ALI	C415A-204
1st Digit Frequency Switch Assembly	ALI	C415A-200
2nd Digit Frequency Switch Assembly	ALI	C415A-201-1
3rd Digit Frequency Switch Assembly	ALI	C415A-201-2
Multiplier Switch Assembly	ALI	C415A-202
1 dB Output Level Attenuator Assembly	ALI	C415A-206
10 dB Output Level Attenuator Assembly	ALI	C415A-205

SYMBOL NUMBER	COMPONENT DESCRIPTION	MANUFACTURER	PART NUMBER
OSCILLATOR BOARD - 6.2.1 (Schematic 6.2.2)			
C2	Capacitor, 390 pF, 500 V	CDE	CD15FD391J03
C3	Capacitor, 4000 μF, 15 V	Sprague	39D408G015UL4
C4	Capacitor, 56 pF, 500 V	CDE	CD15ED560J03
C5	Capacitor, 1000 μF, 6 V	Siemens	B41010F2108-T
C7	Capacitor, 470 pF, 500 V	CDE	CD15FD471J03
C8, 12, 13	Capacitor, 50 μF, 25 V	Amperex	C426AR/F50
C9, 11	Capacitor, 1000 μF, 35 V	Siemens	B41010C7108-T
C14	Capacitor, 82 pF, 500 V	CDE	CD15ED820J03
C15, 16, 17, 18	Capacitor, .01 μF, 50 V	Sprague	TG-S10
CR1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13	Diode		IN914
CR5	Diode, Reference (T.C.)		IN821
Q1, 4, 5, 7, 9, 11	Transistor		2N3906
Q2, 3, 6, 8, 10, 12, 13	Transistor		2N3904
R2, 5, 8, 9, 18, 22, 42	Resistor, 220 Ω, 1/2 W, 5%	A-B	EB2215
R3, 15	Resistor, 1.8 K, 1/2 W, 5%	A-B	EB1825
R4	Resistor, 12 K, 1/2 W, 5%	A-B	EB1235
R6, 26	Resistor, 3.9 K, 1/2 W, 5%	A-B	EB3925
R10	Resistor, 1 K, 1/2 W, 5%	A-B	EB1025
R12, 21, 38, 40	Resistor, 4.7 K, 1/2 W, 5%	A-B	EB4725
R13	Resistor, 24 Ω, 1/2 W, 5%	A-B	EB2405
R14, 43	Resistor, 100 Ω, 1/2 W, 5%	A-B	EB1015
R16, 17, 27, 28	Resistor, 10 Ω, 1/2 W, 5%	A-B	EB1005
R19	Resistor, 22 K, 1/2 W, 5%	A-B	EB2235
R20	Resistor, 14.7 K, 1/4 W, 1%	Corning	RN65C1472F
R23	Resistor, 15 K, 1/2 W, 5%	A-B	EB1535
R24	Resistor, 47 Ω, 1/2 W, 5%	A-B	EB4705
R25	Resistor, 180 Ω, 1/2 W, 5%	A-B	EB1815
R29	Resistor, 3.24 K, 1/4 W, 1%	Corning	RN65C3241F
R30	Resistor, variable, 10 K, 3/4 W, 10%	Beckman	77P
		IRC	980-20
R31	Resistor, 1.210 K, 1/4 W, 1%	Corning	RN65C1211F
R32	Resistor, 1.74 K, 1/4 W, 1%	Corning	RN65C1741F
R33	Resistor, variable, 200 Ω, 3/4 W, 10%	Beckman	77P
		IRC	980-20

R34	Resistor, 301 Ω, 1/4 W, 1%	Corning	RN65C3010F
R35, 36	Resistor, 825 Ω, 1/8 W, 1%	Corning	RN60C8250F
R37	Resistor, 5.6 K, 1/2 W, 5%	A-B	EB5625
R39	Resistor, 470 Ω, 1/2 W, 5%	A-B	EB4715
R41	Resistor, 2.2 K, 1/2 W, 5%	A-B	EB2225

POWER SUPPLY - 6.2.3 (Schematic - 6.2.4)

C1	Capacitor, 500 μF, 75 V	Siemens	B41010K8507-T
C2	Capacitor, .01 μF, 50 V	Sprague	TG-S10
C3	Capacitor, 50 μF, 50 V	Siemens	B41283S6506-T
C8	Capacitor, 200 μF, 15 V	Ducati	200 DUM-12
C9, 10	Capacitor, 50 μF, 25 V	Amperex	C426AR/F50
C11	Capacitor, 10 μF, 40 V	Siemens	B41313B7106-Z
C12	Capacitor, 0 to 6800 pF, 500 V, 5%	CDE	CD15-Type-select
CR5, 6, 7	Diode	Sarkes Tarzian	2F4
CR2	Diode, Zener, 5.6 V	Schauer	SZ5.6
CR3, 4, 8, 9, 10	Diode		IN914
Q1, 4, 7	Transistor		2N3906
Q2, 3, 5	Transistor	RCA	40410
Q6	Transistor	RCA	40409
Q8	Transistor	Motorola	2N4920
R2	Resistor, 620 Ω, 1/2 W, 5%	A-B	EB6215
R3	Resistor, 15 K, 1/2 W, 5%	A-B	EB1535
R4, 5	Resistor, 3.9 K, 1/2 W, 5%	A-B	EB3925
R6	Resistor, 3 K, 1/2 W, 5%	A-B	EB3025
R7	Resistor, 1.5 K, 1/2 W, 5%	A-B	EB1525
R8	Resistor, 2.7 K, 1/2 W, 5%	A-B	EB2725
R9, 10	Resistor, 10 Ω, 1/2 W, 5%	A-B	EB1005
R28	Resistor, 520 Ω, 1/4 W, 0.5%	Corning	RN65C5200D
R29, 30	Resistor, 190 Ω, 1/4 W, 0.5%	Corning	RN65C1900D
R31	Resistor, 848 Ω, 1/4 W, 0.5 %	Corning	RN65C8480D
R32, 33	Resistor, 600 Ω, 1/4 W, 0.5 %	Corning	RN65C6000D
R34	Resistor, 3260 Ω, 1/4 W, 0.5 %	Corning	RN65C3261D
R35	Resistor, 1 K Ω, 1/2 W, 5%	A-B	RC20GF102J
R36	Resistor, 5.1 Ω, 1/2 W, 5%	A-B	RC20GF5R1J
R37	Resistor, 2.2 Ω, 1/2 W, 5%	A-B	RC20GF2R2J
T1	Transformer	UTC	A-20

1ST DIGIT FREQUENCY SWITCH - 6.2.5 (Main Schematic - 6.2.13)			
R26, 27, 54, 58	Resistor, 5205 Ω, 1/8 W, .05%, TCR +120 ppm/°C ±20%	Shallcross	VA-12 Series
R55, 59	Resistor, 2600 Ω, 1/8 W, .05%, TCR +120 ppm/°C ±20%	Shallcross	VA-12 Series
R56, 60	Resistor, 1298.7 Ω, 1/8 W, .05%, TCR +120 ppm/°C ±20%	Shallcross	VA-12 Series
R57, 61	Resistor, 741.9 Ω, 1/8 W, .05%, TCR +120 ppm/°C ±20%	Shallcross	VA-12 Series
R62, 63	Resistor, select, 1/2 W, 5%, nominal value 220 K	A-B	EB Series
S4	Switch, pushbutton, 4PDT, 10 button, OFF - 9	Centralab (ALI)	PB-15 Series/ (C5906-2)
2ND DIGIT FREQUENCY SWITCH - 6.2.6 (Main Schematic - 6.2.13)			
R46, 50	Resistor, 52.0 K Ω, 1/4 W, 0.5%	Corning	RN65C5202D
R47, 51	Resistor, 26.0 K Ω, 1/4 W, 0.5%	Corning	RN65C2602D
R48, 52	Resistor, 13.0 K Ω, 1/4 W, 0.5%	Corning	RN65C1302D
R49, 53	Resistor, 7.43 K Ω, 1/4 W, 0.5%	Corning	RN65C7431D
S2	Switch, pushbutton, 4PDT, 10 button, 0 - 9	Centralab (ALI)	PB-15 Series/ (C5906-1)
3RD DIGIT FREQUENCY SWITCH - 6.2.7 (Main Schematic - 6.2.13)			
R38, 42	Resistor, 520 K Ω, 1/4 W, 0.5%	Corning	RN65C5203D
R39, 43	Resistor, 260 K Ω, 1/4 W, 0.5%	Corning	RN65C2603D
R40, 44	Resistor, 130 K Ω, 1/4 W, 0.5%	Corning	RN65C1303D
R41, 45	Resistor, 74.3 K Ω, 1/4 W, 0.5%	Corning	RN65C7432D
S3	Switch, pushbutton, 4PDT, 10 button, 0 - 9	Centralab (ALI)	PB-15 Series/ (C5906-1)

MULTIPLIER SWITCH - 6.2.8 (Main Schematic - 6.2.13)

C4, 5	Capacitor, 0.3 μF, 100 V	Nytronics	PH30031C2Z
C6, 7	Capacitor, 0.03 μF, 100 V	Nytronics	PH30021C2Z
C4A, 5A	Capacitor, 560 to 2700 pF, 500 V, 5%	CDE	CD15-Type-select
C4B, 5B	Capacitor, 0 to 1600 pF, 500 V, 5%	CDE	CD15-Type-select
C6A, 7A	Capacitor, 50 to 430 pF, 500 V, 5%	CDE	CD15-Type-select
C6B, 7B	Capacitor, 0 to 150 pF, 500 V, 5%	CDE	CD15-Type-select
S1	Switch, pushbutton, 4PDT, 2 button X1 & X10	Centralab (ALI)	PB-15 Series/ (C5906-3)

1 dB OUTPUT LEVEL ATTENUATOR - 6.2.9 (Main Schematic - 6.2.13)

R16, 18	Resistor, 103 Ω, 1/4 W, 0.5%	Corning	RN65C1030D
R17	Resistor, 1700 Ω, 1/4 W, 0.5%	Corning	RN65C1701D
R19, 21	Resistor, 68.8 Ω, 1/4 W, 0.5%	Corning	RN65C68R8D
R20	Resistor, 2580 Ω, 1/4 W, 0.5%	Corning	RN65C2581D
R22, 24	Resistor, 136 Ω, 1/4 W, 0.5%	Corning	RN65C1360D
R23	Resistor, 1260 Ω, 1/4 W, 0.5%	Corning	RN65C1261D
R25, 27	Resistor, 34.8 Ω, 1/4 W, 0.5%	Corning	RN65C34R8D
R26	Resistor, 5200 Ω, 1/4 W, 0.5%	Corning	RN65C5201D
S6	Switch, 8 pole, 11 position	Oak (ALI)	27608-F4/ (C5908)

10 dB OUTPUT LEVEL ATTENUATOR - 6.2.10 (Main Schematic - 6.2.13)

C2	Capacitor, DSM, 0 to 320 pF, 500 V, 5%	CDE	CD15-Type-select
C3	Capacitor, DSM, 130 pF, 500 V, 5%	CDE	CD10FD131J03
R7	Resistor, 4700 Ω, 1/4 W, 0.5%	Corning	RN65C4701D
R8	Resistor, 19.6 Ω, 1/4 W, 0.5%	Corning	RN65C19R6D
R9	Resistor, 66.7 Ω, 1/4 W, 0.5%	Corning	RN65C66R7D
R10	Resistor, 277 Ω, 1/4 W, 0.5%	Corning	RN65C2770D
R11	Resistor, 18. K Ω, 1/4 W, 0.5%	Corning	RN65C1842D
R12	Resistor, 5400 Ω, 1/4 W, 0.5%	Corning	RN65C5401D
R13	Resistor, 1300 Ω, 1/4 W, 0.5%	Corning	RN65C1301D
R14, 15	Resistor, 600 Ω, 1/4 W, 0.5%	Corning	RN65C6000D
R64	Resistor, 300 Ω, 1/4 W, 0.5%	Corning	RN65C3000D
S7	Switch, rotary, pc mount, 3 pole, 4 position	CTS (ALI)	212-27303-1/ (B5907)

FRONT PANEL AND CHASSIS MOUNTED PARTS - 6.2.12 (Schematic - 6.2.13)

PL-1	Pilot lamp	Dialco	126-4428-0351-200
R1	Resistor, dual, variable Section A: 100 Ω ± 30%, linear taper Section B: 25 K Ω ± 30%, linear taper	CTS (ALI)	T2-450 Type/ (B5909)
R2	Resistor, dual, variable/switch Section A: 100 Ω ± 30%, linear taper Section B: 25 K Ω ± 30%, linear taper SPST rotary (integral with R2)	CTS (ALI)	RGC-T2-450D Type/ (B5900)
R3	Resistor, dual, variable/switch 2 sections: 250 Ω, linear taper/DPST rotary (integral with R3)	CTS (ALI)	RWF-T2-450D Type/ (B5901)
R5, 6	Resistor, 125 Ω, 1/8 W, .05% TCR +120 ppm/°C ± 20%	Shallcross	VA-12 Series
R35, 36	Resistor, 600 Ω, 1/4 W, 0.5%	Corning	RN65C6000D
R37	Resistor, 3260 Ω, 1/4 W, 0.5%	Corning	RN65C3261D

LIST OF MANUFACTURERS

Abbreviation	Complete Name and Address
A-B	Allen-Bradley Company 1201 South Second Street Milwaukee, Wisconsin 53204 USA
ALI	Bowmar/ALI, Inc. 531 Main Street Acton, Massachusetts 01720 USA
Amperex	Amperex Electronics Corporation Component Division 35 Hoffman Avenue Hauppauge, New York 11787 USA
Beckman	Beckman Instruments, Inc. Helipot Division 2500 Harbor Boulevard Fullerton, California 92634 USA
Cambion	Cambridge Thermionic Corporation 445 Concord Avenue Cambridge, Massachusetts 02138 USA
CDE	Cornell Dublier Electronics 50 Paris Street Newark, New Jersey 07101 USA
Centralab	Centralab 5757 North Greenbay Avenue Milwaukee, Wisconsin 53209 USA
Corning	Corning Glass Works Electronic Products Division Houghton Park Corning, New York 14830 USA
CTS	CTS Corporation 1142 West Beardsley Avenue Elkart, Indiana 46514 USA
Dialco	Dialight Corporation 60 Stewart Avenue Brooklyn, New York 11237 USA

Ducati	Ducati Distributor Consolidated Distributors, Inc. 129 Hudson Street New York, New York 10013 USA
IRC	International Resistor Corporation Division of TRW 401 North Broad Street Philadelphia, Pennsylvania 19108 USA
Nytronics	Nytronics, Inc. Capacitor Division Orange Street Darlington, South Carolina 29532 USA
Oak	Oak Manufacturing Company Division Oak Electro/Netics Corporation Department EL Crystal Lake Avenue Crystal Lake, Illinois 60014 USA
RCA	RCA Electronic Components 415 South Fifth Street Harrison, New Jersey 07029 USA
Sarkes Tarzian	Sarkes Tarzian, Inc. Semiconductor Division 415 North College Avenue Bloomington, Indiana 47402 USA
Schauer	Schauer Manufacturing Corporation 4516 Alpine Avenue Cincinnati, Ohio 45442 USA
Shallcross	Shallcross East Preston Street Selma, North Carolina 27576 USA
Siemens	Siemens America, Inc. Telecommunications Division 350 Fifth Avenue New York, New York 10001 USA
Sprague	Sprague Electric Company 125 Marshall Street North Adams, Massachusetts 01247 USA
UTC	United Transformer Company Division TRW, Inc. 150 Varick Street New York, New York 10013 USA

8.0 SUPPLEMENTARY DATA

8.1 Guarantee

Bowmar/ALI, Inc. guarantees to the original purchaser that this instrument is in accordance with applicable specifications. Any deviation from these specifications and any defects in workmanship or materials will be corrected by Bowmar/ALI, Inc., provided the instrument has been properly used under normal operating conditions. This guarantee is effective for one year from date of shipment except for failure of or attributable to tubes, fuses, batteries, or semiconductors after ninety days from date of shipment. Bowmar/ALI, Inc. will be the sole judge of the validity of all claims.

All returns made under this guarantee must be authorized in writing by Bowmar/ALI, Inc. Such authorization will be given only upon receipt of information concerning type, serial number, and the defect claimed. Return shipments must be made prepaid except returns authorized within thirty days from date of shipment, in which case Railway Express Collect will be authorized. All rework done under this guarantee will be re-shipped prepaid from our plant.

Bowmar/ALI, Inc. will not be responsible for, nor assume any expense or liability for, damage of loss in shipment, loss of profit, or any other damages or claims for which provisions are not specifically made herein.

8.2 Material Damaged in Shipment

Upon receipt of the instrument, do not unpack if the packing case shows evidence of damage; upon unpacking, do not discard any of the packing if damage is found which appears to have been caused by shipment. Immediately notify the local office of the carrier and request that the damage be inspected; also, notify Bowmar/ALI, Inc. of the model number, serial number, carrier's number, date received, and any other pertinent information so that we may contact the local carrier office and facilitate a speedy settlement of any claim.

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